INDEPENDENT OFFICES APPROPRIATIONS FOR 1953

TUESDAY, FEBRUARY 19, 1952

UNITED STATES SENATE,
SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS,
Washington, D. C.

The subcommittee met at 10:15 a. m., pursuant to adjournment, in room F–82, the Capitol, Hon. Burnet R. Maybank (chairman of the subcommittee) presiding.

Present: Senators Maybank, Ellender, and Thye.

ATOMIC ENERGY COMMISSION

REACTOR PROGRAM AND RELATED FACILITIES

STATEMENTS OF MARION W. BOYER, GENERAL MANAGER; AND DR. LAWRENCE R. HAFSTAD, DIRECTOR OF THE DIVISION OF REACTOR DEVELOPMENT OF THE ATOMIC ENERGY COMMISSION

CONSTRUCTION PROGRAM

Senator MAYBANK. I think that we will proceed at this time, and I am hopeful that we will be able to have more Senators present at a later time.

The main purpose of this meeting is to make a record, and anything that is going to be testified to this morning, as I understand it, is not secret or classified in any way.

Mr. BOYER. We have certain portions of the reactor program that will have to be off the record, which we will make as brief as we can. Dr. Hafstad has an unclassified statement which he can present.

Senator MAYBANK. Doctor, will you go ahead. This is on the reactor program.

ESTIMATED COSTS

Dr. HAFSTAD. For the fiscal year 1953 the Commission is estimating costs of $92,400,000 for development of new reactors plus $44,100,000 to be obligated for construction of experimental reactors and related facilities, a total of $136,500,000. This compares with estimated development costs of $65,204,000 in fiscal year 1952 plus $50,147,317 for construction, a total of $115,351,317. This is a growing program, that is the most important thing.

REACTORS

As is fairly well known by this time, reactors are the machines for converting atomic energy into useful work. You see, just as the bomb

releases this enormous store of energy instantaneously to get the greatest blast effect, in reactors we release the same amount of energy in a controlled manner, letting it come out a little bit at a time, and thereupon getting in the end electrical energy for useful work. This can be done in two general areas, for mobile reactors which we will talk about separately for the military, or for civilian power ultimately if and when we get the costs down.

Senator MAYBANK. That is why I repeated the word "useful," when you said that, because I presume you intended to lead up to the civilian end, because that is what we have all been so interested in on account of thinking about what might happen, as Senator Thye said yesterday, and as Senator Ellender remarks about this, if you have peace.

DEVELOPMENT PROGRAM

Dr. HAFSTAD. From the long-term point of view, the development of reactors is the main hope, and almost the only hope, of appreciable civilian use of atomic power. For the immediate future, very little distinction can be made between reactors for civilian uses and reactors for military uses. In general the same ground must be covered in order to learn how to design a power-producing reactor for any purpose. Because economic factors are less compelling for military planes and submarines than for central station power plants, the military can justify reactor development and construction which cannot be justified on a civilian basis. Fortunately, the knowledge acquired for the military will be available for civilian application.

I can expand on that a little bit to indicate why it is that the military can justify higher prices for nuclear power than civilians. I have gotten these figures from the Navy recently, for example, and this is unclassified. Apparently for major naval vessels, the power that they use costs in the neighborhood of 2 cents a kilowatt-hour. This is about four times as much as we pay in civilian life. In submarines for normal submarines it goes as high as 8 cents per kilowatt-hour, and for some of the special-purpose submarines which are designed for very high speed for very short times, it goes up in the neighborhood of $1 a kilowatt-hour.

NUCLEAR POWER

Senator MAYBANK. Why is that? I imagine when you talk about power that you have down at Clarks Hill on the Savannah project, you have got a tremendous water power which will be supported by steam. The submarine would not use much electric power.

Dr. HAFSTAD. The submarine would not use as much, so that there is a scale factor in that, but the main thing is the hauling of the fuel and so on. They are operating under very restricted conditions and in order to have high range they have to carry a lot of fuel. They are hauling this fuel around and that pushes their costs up.

Senator MAYBANK. Do you mean hauling the fuel on the submarine?

Dr. HAFSTAD. On their own submarine. With nuclear power we avoid the job of hauling around the fuel. It is fairly compact, as you know. For this reason in the naval applications, there is a much more promising opportunity for nuclear power at the present time than in civilian use.

For either civilian or military uses, the extent to which atomic power will prove practical will depend mainly on the adequacy of the supply of raw materials, both as to cost and as to the amount available.

Senator MAYBANK. The cost is the main thing?

Dr. HAFSTAD. That is the most important now.

Senator MAYBANK. I hope you don't mind being interrupted, but how long do you think it will be before you are going to get the cost down? Are you getting it gradually down, or what is the status of it?

Dr. HAFSTAD. The cost is coming down gradually.

Senator MAYBANK. The reason I asked is because this committee is appropriating huge sums of money to build power dams and if you have got this cost down within reason, it seems to me that so much of the land that is being flooded throughout the country might be saved.

POWER COSTS

Dr. HAFSTAD. I think that I can state this, that having looked over costs of power since this is the basis on which this whole program has to be planned, it is quite clear that hydroelectric power is the cheapest that we have available at the present time, and so it will be the last which will be replaced by muclear energy, if ever.

Senator MAYBANK. Nuclear power might replace the steam plants, but hydroelectric power is a low-cost power?

Dr. HAFSTAD. If coal costs continue to rise, and if the power demands continue to rise, forcing the coal costs higher and higher, then I think nuclear power will be able to compete in 20 years or something less, but it is still some time off.

Senator MAYBANK. That is 20 years?

Dr. HAFSTAD. Yes, or maybe sooner, and we are moving in that direction.

Senator MAYBANK. As I understand it you are going to build some steam plants down on the Savannah River project, are you not, because the power companies of course are going to forward their power to the towns there and so on, but I understood they did not have enough power to do that and have it inside the project, too.

Mr. BOYER. That is correct, and where we have those needs for power we have to look toward construction of new power facilities to supply our specific needs.

PRODUCTION MACHINERY

Senator ELLENDER. Going to the development of our present facilities for the production of this energy, I presume that the same machinery now being erected to create this power would be used if we turned everything to civilian use, that is in the manufacture of the products?

Mr. BOYER. I think we made the point yesterday that you wouldn't be building an expansion today if it were just for civilian use.

Senator ELLENDER. I understand that, but ultimately as I understood it from the beginning we more or less have a dual purpose here, to create it for war purposes as well as civilian use in the long run and that is one of the reasons assigned why we should go on with it.

Mr. BOYER. Well, you couldn't just provide for expansion today. Now, the nuclear material does have a utility in power plants, at some

subsequent date, but to say that you would expend this amount of money today to store that material up, I think would give the wrong impression, because you wouldn't spend money for an expansion today just to store up this material to use in the future for peacetime effort.

Senator ELLENDER. What I had in mind was the production of the power itself. Would you not use the same machinery as you would the other way? You design the reactor differently today if you are going to make power, and that is, I think, the point that Dr. Hafstad is bringing out, that a part of this program, of course, will develop the type of reactor that will produce power.

Dr. HAFSTAD. I think this will come out a little later, and I can pick that point up when we get to that. I think we can answer your question.

Senator ELLENDER. All right.

BREEDER REACTORS

Dr. HAFSTAD. As is well known, most reactors to date utilize only the fissionable isotope of uranium, which constitutes only seven-tenths of 1 percent of the supply of uranium, in its natural state. For this reason, investigations continue toward a "breeder" type of reactor which, it is hoped, may make possible the utilization of our entire supply of uranium and thorium, and thus multiply many times our potentially available reserves of nuclear fuel. Now this point I want to stress, that the "breeder" reactor is one we are pressing hard at the moment because it promises not to increase the total reserves by a factor of 50 percent or 100 percent, but a factor of something like 100 so that the amount of material that we have shipped into this country and is now being stored will represent really enormous stockpiles of energy if and when we can get this "breeder" reactor working, and this "breeder" reactor will continue to produce plutonium which is of interest to the military for bombs, and simultaneously produce large amounts of electric power, and this comes to the question we were discussing a few minutes ago. What we are struggling to do in this program is to learn enough technically so that we will be able to design these dual purpose reactors which will simultaneously give the military the bomb material, and the civilian economy electric power. This is the big difficulty.

Senator ELLENDER. Now, reactors for what? For the utilization of this product that you are now making; is that not it?

Dr. HAFSTAD. These reactors will utilize the uranium which we have shipped into the country, and paid for, and have at least to some extent chemically processed by our big processing facilities.

Senator ELLENDER. Now, the facilities that are now being erected for the production of this product on which you are going to use your reactors, would be the same for civilian as for Army use; would it not?

Dr. HAFSTAD. Many of them, but to be accurate we have to say that also many of these facilities are at the present time for the special purpose of plutonium production, which is usable in bombs, and planned only for use in bombs at the present time. So this is a cost essentially chargeable to the over-all defense of the Nation. That is over and above the thing which will contribute in the long run here.

In the current program, six reactors are planned for full-scale development and ultimate construction. One is designed to give increased output of fissionable material and one is a "breeder," three are straightforward attacks on the problem of a reactor for submarine propulsion, and one is an experiment in the field of aircraft propulsion. In addition, two small "pilot" reactors, called experiments, will be assembled, one of the homogeneous type and the other of the aircraft propulsion type. Several other reactors of different design are in preliminary stages of development.

Further along than the reactors mentioned above are an experimental breeder and a materials testing reactor on which development has been completed. In an experiment last December, electric power from atomic source was generated for the first time in history by using heat from the breeder, although on an uneconomical basis.

I thought you gentlemen might want to see a picture of one of these reactors, especially this one, since it is historic. This is one that is on a scale here, and this is the concrete shield. The reactor itself is a relatively small unit, right down in the center of this block of concrete which is the shield. From this we pull out the power. I will pass this picture up to the chairman in just a moment. This gets hot in here, and we pull out that heat and run it through heat exchangers, that is just a piping system. We have tried by encouraging research activities to seek ways whereby nuclear energy can be converted directly into electrical power. This would obviously be highly desirable because it would skip this expensive stage of going through all of the plumbing, and the steam generation, and turbines and so on. So far we have not had a single inkling of any way whereby this can be done directly.

We have to take the nuclear energy and convert to heat and use the heat to convert to steam or some other heat transfer medium and then use that in the end to get electrical power.

Senator THYE. You see no way of hooking it up so that it has a draw the same as electrical current can be converted into a draw on a motor device.

Dr. HAFSTAD. Not directly, this is one of the things which might emerge out of the research program, at any time, because unexpected things happen in research programs.

Senator THYE. But you do not see any avenues at the present time?

Dr. HAFSTAD. At the present time it looks unlikely.

Senator THYE. There are no avenues open even on that?

Dr. HAFSTAD. There are no avenues open even, no.

Senator MAYBANK. All right, Doctor Hafstad, proceed.

COST ESTIMATES

Dr. HAFSTAD. Development costs are rising particularly in the areas of improved production reactors and aircraft propulsion reactors as major programs get under way. Costs of operating experimental reactors and chemical processing plants also are rising appreciably as the number of such facilities increases.

Cost estimates in this budget are based on the scheduling of foreseeable problems by years for the several contractors. Each problem is analyzed to estimate the man-years of scientific and engineering

talent and materials required. To the cost of the man-years and materials is added the proportionate share of indirect expenses to be incurred by the contractor. Performance during prior years has been considered in the assignment of work, in assessing ability to expand, and in determining cost estimates. The possibility of development or operation of reactors by industry on a "risk" basis has been encouraged by the Commission and is being explored by several large industrial companies at this time.

Mr. BOYER. I would suggest, Mr. Chairman, that we insert the material contained on pages 171 through 179 in the record, since that is unclassified.

Senator MAYBANK. Without objection, the materials contained on 171 through 179 will be placed in the record.

(The material referred to is as follows:)

OPERATING PROGRAM SUMMARY AND NARRATIVE STATEMENT

Reactor development

	1951 actual	1952 estimate	1953 estimate
Research and development:			
Specific reactor projects	$32,583,388	$46,713,135	$62,905,300
General reactor research and development	6,593,009	11,627,265	15,106,000
Operation of specific reactors and processing plants	1,395,614	6,863,600	14,388,700
Total accrued costs	40,572,011	65,204,000	92,400,000

In the reactor-development program nuclear reactors and ancillary equipment and facilities are being developed to improve production of fissionable material; to be primary energy sources for naval vessel and military aircraft propulsion systems; to produce fissionable material as joint products or byproducts of military and industrial applications; and to be research tools.

The program in 1952 and 1953 continues to rise rapidly under pressures for new or more efficient reactor designs. The ground work for this growth was laid in 1949 with establishment of a new Division of Reactor Development to coordinate and direct a vigorous program to develop new reactors. Staffs of the Commission laboratories were strengthened and several major new contractors were engaged to supplement their efforts. The cumulative effect of strengthening staffs plus the addition of new contractors since that year has resulted in the gaining of a greater amount of knowledge in reactor technology. This foundation is now serving to permit an increase in the number of new reactor concepts which can be developed simultaneously. It also serves to shorten the over-all development time.

The development program continues to be centered primarily in Commission-owned laboratories but we are turning more and more to new industrial contractors to accomplish additional growth. Percentagewise, the growth of reactor-development programs in Commission-owned facilities in 1952 is 29 percent and a further 14-percent rise in 1953. Compared to this, the increase in industrial contracts in 1952 is 265 percent with a further increase of 177 percent in 1953. This shift is permitted by the growing interest of business in the program and the fact that engineering is playing a relatively larger part than it formerly did.

Major increases are planned in the development of improved production reactors and mobile propulsion reactors. General reactor research also is expanding to permit work on breeding studies now that the experimental breeder reactor is operating, and to increase the effort on new designs, waste treatment, and improved chemical separations. Work on improved materials continues to be a major activity. Total costs of operating plants rises as the number of such plants increases.

Outstanding achievements in 1951 were the virtual completion of development of the experimental breeder reactor and the materials-testing reactor and the achievement of large-scale production of zirconium and beryllium.

An analysis of the development effort between major laboratories and contracts is shown in the following table:

Activities	1951 actual	1952 estimate	1953 estimate
A. In AEC-owned facilities:			
Argonne Laboratory, Du Page, Ill.	$9,121,862	$9,149,700	$12,308,400
Brookhaven Laboratory, Long Island, N. Y.	507,236	1,127,100	1,127,000
Knolls Laboratory, Schenectady, N. Y.	8,413,683	9,186,900	9,982,000
Mound Laboratory, Dayton, Ohio	215,932	272,000	286,000
Oak Ridge Laboratory, Oak Ridge, Tenn.	9,019,874	11,525,085	14,573,500
Pittsburgh Laboratory, Pittsburgh, Pa.	7,152,253	13,515,200	17,919,300
Reactor testing station, Arco, Idaho	1,999,533	6,674,450	9,153,200
Total	36,430,373	51,450,435	65,349,400
B. Major continuing contracts in non-AEC-owned facilities:			
Battelle Memorial Institute, Columbus, Ohio (Chicago area)	580,298	844,200	811,700
Brush Beryllium Co., Cleveland, Ohio (New York area)	0	150,000	141,200
General Electric Co., Lockland, Ohio (Lockland area)	0	4,337,000	9,408,000
Massachusetts Institute of Technology, Cambridge, Mass. (New York area)	608,697	475,000	447,100
North American Aviation, Inc., Los Angeles, Calif. (Chicago area)	1,420,400	2,233,800	2,840,700
Sylvania Electric Products Co., Long Island, N. Y. (New York area)	276,639	405,700	382,700
Total	2,886,034	8,445,700	14,031,400
C. Smaller contracts	1,255,604	3,312,700	1,893,800
D. Contracts not yet awarded	0	1,995,165	11,125,400
Total	40,572,011	65,204,000	92,400,000

Detailed Justification of Operating Costs

REACTOR DEVELOPMENT, RESEARCH AND DEVELOPMENT

Specific reactor projects

General

In this category are presented the estimates for developing new reactors. It includes costs of research, development, and engineering but does not include architect-engineer or construction costs. Estimates are based on the number of scientists and engineers to be assigned to each project, plus the cost of special materials for experiments.

Reactors designed to meet the present goals of the reactor development program improved reactors for production of fissionable materials, production reactors with byproduct electrical energy, reactors for breeding fissionable material, and mobile reactors for propulsion of naval vessels and military aircraft—represent large technological advances over reactors now in operation. To solve the many difficult problems requires the development and evaluation of new construction materials together with development of methods of production, purification and fabrication, the development of new coolants and associated heat-transfer equipment, the measurement of nuclear and physical properties of many materials, and many theoretical and experimental studies. Because of the progress being made in these broad fields of reactor technology it is possible to place increased emphasis on engineering design and the immediate problems of applied research in the development of specific reactors.

The accelerated pace at which the Commission is pushing toward the completion of reactors which will represent significant advances toward meeting both military and civilian needs of this country is reflected in the rising cost of this category.

Because of the number of projects under way, details are presented by subclassifications on the following pages:

1. Production reactors:

1951, actual	$3,656,109
1952, estimated	8,481,885
1953, estimated	19,479,000

In this classification are presented those reactor-development projects which have a strong bearing on future improvement in the production of fissionable materials. These projects cover a number of alternate approaches which show promise of superior performance to the Hanford and Savannah River reactors in such areas as lower over-all cost, greater yield of fissionable material from a given ore supply, or simultaneous production of useful power. Most of these projects are in early phases with work emphasizing preliminary evaluation of feasibility and performance. A limited number of these projects will be carried through full-scale development and construction in the next few years as a final proof of performance.

Early in calendar year 1951 the Commission determined to put greater emphasis on improved production designs. This decision is reflected in the more than doubling of the 1951 program in 1952 and again more than doubling the 1952 program in 1953. Two new contractors will be added to this program in 1952, in addition to the five now engaged to aid in the engineering development of the new designs. Two additional prime contractors will be added in 1953.

It is the intention of the Commission that the development of improved production reactors will arrive as rapidly as possible at the point where new and more efficient designs can be used, after proof of actual operability, should additional production of fissionable material be required.

In this classification the development of one important reactor, the experimental breeder, was completed by the Argonne Laboratory and placed in operation in fiscal year 1952 as a tool for use in further studies of the breeding phenomena. Also completed in fiscal year 1951 was an extensive study which resulted in the selection of a design concept for use at Savannah River.

Effort is primarily at the Argonne, Brookhaven, Knolls, and Oak Ridge Laboratories, and North American Aviation, Inc. These efforts are supplemented by industrial contractors employed for specific projects as required.

2. Naval vessel and military aircraft reactors:

1951 actual	$27,469,814
1952 estimated	36,634,200
1953 estimated	43,395,800

This subclassification of projects for development of specific reactors includes those primarily designed for use in propulsion systems for naval vessels and military aircraft. The program is based on specific requests from the military for reactors for those purposes.

While these reactors are designed for military purposes, it should be clearly recognized that each is advancing the frontier of knowledge in reactor technology and thus is directly benefiting the development of all types of reactors. For example, the submarine reactor will be the first reactor type to be put to a practical use other than for research or production purposes.

The submarine intermediate reactor will be one of the first power reactors as well as the first such reactor to use a liquid coolant and operate with intermediate neutrons.

One additional prime contractor was added in June 1951 and one more will be added in fiscal year 1953.

Effort is primarily at the Argonne, Knolls, Oak Ridge and Pittsburgh laboratories. These efforts are supplemented by industrial contractors employed for specific projects as required.

3. Research reactors:

1951 actual	$1,457,465
1952 estimated	1,597,050
1953 estimated	30,500

Effort in this area will be temporarily discontinued to permit greater attention to production and military reactors. Effort on the material testing reactor will be completed in fiscal year 1952 by the Argonne and Oak Ridge laboratories and the reactor will be operated for the first time in that year at the reactor testing station.

Argonne laboratory has begun construction of its new research reactor and preliminary design of a new low power research reactor has been completed by North American Aviation, Inc., but will not be constructed at this time.

General Reactor Research and Development

General

This category includes that body of applied research and development not directly attributable to any of the specific reactors now under design but which is

required as the foundation for the development of reactors of the future. It is in this program that new materials are tested and developed, new systems designed and tested for future application, and in which the Commission is adding to the store of knowledge in the field of reactor technology.

1. Reactor design and evaluation:

1951 actual	$170,286
1952 estimated	776,100
1953 estimated	1,382,000

This activity is to create and evaluate new reactor designs through the stages of preliminary design and feasibility report. Designs and related funds are transferred from this activity to the category of specific reactor projects upon acceptance. Appropriations for this purpose in 1951 were $1,898,000 and for 1952 were $1,640,900. During that period six designs were accepted for further study as specific projects. Effort is primarily at the Argonne, Oak Ridge and Knolls laboratories.

2. Reactor physics and critical assembly work:

1951 actual	$582,974
1952 estimated	1,079,800
1953 estimated	1,512,000

This activity is to develop information through experimentation to improve and check theoretical and analytical methods for predicting conditions within a reactor and to add to information in theoretical and experimental nuclear physics concerned with the processes and principles of the nuclear chain reaction. Effort is primarily at the Argonne and Knolls laboratories. The increase of $432,200 is for additional studies of breeding using the new experimental breeder reactor and for expanding the effort on determination of cross section measurements using the new materials testing reactor.

3. Reactor fuel system:

1951 actual	$357,375
1952 estimated	1,003,400
1953 estimated	1,429,000

This activity is to develop improved fuel system for reactors, to improve physical and nuclear properties, and to improve metallurgical and handling techniques. Effort is primarily at Argonne Laboratory. The increase of $425,600 is to expand effort on uranium alloys and new metallurgical techniques.

4. Materials and components:

1951 actual	$2,483,735
1952 estimated	3,715,600
1953 estimated	3,717,000

This activity is to develop new materials and to improve characteristics of materials for use in the structure or components of reactors, to test materials under reactor conditions, to improve metallurgical techniques and to develop new production processes. Effort is primarily at the Argonne, Knolls, and Oak Ridge laboratories, North American Aviation, Inc., Massachusetts Institute of Technology and by a number of smaller contracts.

5. Coolants, heat transfer and power generation:

1951 actual	$117,055
1952 estimated	287,800
1953 estimated	532,000

This activity is to develop improved cooling and heat transfer materials and systems, their components and their nuclear and engineering characteristics. Effort is primarily at the Argonne Laboratory. The increase of $135,200 is for expanding studies of liquid metal systems using the experimental breeder reactor.

6. Instrumentation and control:

1951 actual	$31,331
1952 estimated	217,900
1953 estimated	238,000

This activity is to develop more effective and reliable instruments, controls and control materials and safety devices for reactors. Effort is primarily at

Argonne Laboratory. Effort on monitoring systems and automatic alarms is being expanded slightly.

7. Shield development:

1951 actual	$542,260
1952 estimated	620,400
1953 estimated	845,000

This activity is to determine the materials, their combinations and their configurations, which will achieve optimum shield efficiency, shield cooling systems, and improved methods and devices for remote control and handling of work behind shields. Effort is primarily at the Argonne and Brookhaven laboratories. The increase of $224,060 is expanded effort on remote handling devices and compilation of a shield data handbook.

8. Separations systems:

1951 actual	$413,849
1952 estimated	861,765
1953 estimated	2,240,000

This activity is to develop chemical systems to recover as much fissionable material as possible from all stages of handling spent fuel elements. Effort is primarily at the Argonne, Knolls, and Oak Ridge laboratories. The increase of $1,378,235 is for greatly expanded effort for new processes for the fuels from reactors, and for simplified recovery methods.

9. Waste treatment systems:

1951 actual	$1,123,109
1952 estimated	1,836,300
1953 estimated	1,873,000

This activity is to develop systems to recover process materials, to reduce waste volumes, to isolate, package and dispose of waste, to control and decontaminate effluents, and to seek economic uses for materials now considered as waste. Effort is primarily at the Argonne, Brookhaven, Knolls, Mound, and Oak Ridge laboratories, supplemented by a number of smaller contracts. Projects seeking economic uses will cost about $400,000 in 1952 and $635,000 in 1953.

10. Sanitary engineering:

1951 actual	$500,990
1952 estimated	758,300
1953 estimated	710,000

This activity is to determine the effects of proposed and existing reactors and processing plants on the surrounding environment and to develop means of controlling those effects. Effort is carried on by a number of contractors, including the United States Weather Bureau and Geological Survey.

11. Training and education:

1951 actual	$250,673
1952 estimated	400,000
1953 estimated	567,000

This activity is to train scientists and engineers for research and development in the field of reactor technology. Effort currently is confined to the School of Reactor Technology at Oak Ridge. The increase of $167,000 is for expansion of the enrollment from 67 to about 80 per school year to keep pace with the expanding use of reactors and reactor developments. Enrollment is open to employees of industry as well as to recent college graduates. The latter are considered employees of the Oak Ridge laboratory and are paid stipends of $3,000 to $4,200 a year depending on the number of dependents. The average is $3,420. The former are paid by their employers. About one-third of the students are from industry. The course includes theory and experimentation. The estimate is based on 55 college graduates at $3,420, or $188,000, plus instructors salaries, $65,000, plus material for experiments, $61,000, plus indirect expenses of $253,000.

12. Security shipment expense:

1951 actual	$19,372
1952 estimated	69,900
1953 estimated	70,000

This activity is for shipment security salary and travel expenses by the Chicago operations office allocable to this program for shipments of classified materials.

Operation of specific reactors and processing plants

General

This category provides for the cost of operating specific reactors and processing plants, and the reactor testing station. At the appropriate time in the future when the plants are operating on a routine basis and work can be scheduled well in advance it is planned to charge all of these costs to the using activities. This budget category then will contain only net, uncharged costs. Through fiscal year 1953 this category reflects the estimated operating costs of the facilities listed.

The increase in 1952 over 1951 is caused by initial operation of two new reactors preparation for start up for the first time of one new reactor, and for initial full scale operation during the year of the new chemical separation plant. The further increase in 1953 reflects full-year full-scale operation of the reactors and the chemical plant.

1. Operation of specific reactors:

1951 actual	0
1952 estimated	$2, 720, 100
1953 estimated	8, 130, 200

This classification is for operating costs of experimental reactors. The increase of $5,410,100 is to provide for a full year's operation of several new reactors for the first time.

2. Operation of chemical separation plant:

1951 actual	$290, 669
1952 estimated	2, 300, 100
1953 estimated	4, 142, 300

This activity is for operation of the new multipurpose chemical separation plant at the reactor testing station, Arco, Idaho. The plant is operated by the American Cyanamid Co. with 297 employees. The plant will begin full-scale operation late in fiscal year 1952. The increase of $1,842,200 is to permit full-scale operation for one full year.

3. Operation of central services, reactor testing station:

1951 actual	$1, 104, 945
1952 estimated	1, 843, 400
1953 estimated	2, 116, 200

This activity is for operation of central services at the reactor testing station, Arco, Idaho. It provides for maintenance and operation of the utility systems, railroad, roads, refuse collection, warehouses, shops, fire department, medical and health physics services, safety, security and guard system, and operation of a bus system. The increase of $272,800 is for additional services for new operating areas to be completed in fiscal year 1952.

Additional information of a classified nature is presented in the following pages 180–250.

CONVERSION OF REACTOR HEAT TO ELECTRICAL ENERGY

Dr. HAFSTAD. I would like to expand a little bit on this industrial participation, because I think that you gentlemen would be very much interested in that. As I have indicated, reactors are used at the present time at Hanford and Savannah River mainly for the production of fissionable material.

Heat is released in the process of making this plutonium, but the heat is wasted at the present time.

Senator MAYBANK. Are you studying it so that it will not be wasted.

Dr. HAFSTAD. We are working hard, and that is what these production reactor improvements contain to a large extent.

Senator MAYBANK. Is there much heat wasted?

Dr. HAFSTAD. Relatively enormous quantities of heat are wasted; it is generated and wasted in the production reactors, so that the new production reactors we hope to design will be reactors which will produce just as much plutonium at no greater cost as far as the plutonium

is concerned, and will in addition enable us to utilize the heat to generate electric power and get a credit against the cost of plutonium.

Senator THYE. What you propose to do is to put in your steam turbines, and that heat will create the steam which will operate the steam turbines.

Dr. HAFSTAD. That is correct.

Senator THYE. Then you have a plant cost there, of the installation, which represents how much money?

Dr. HAFSTAD. Well, depending on the scale at which you are operating.

Senator THYE. You are generating how many kilowatts?

Dr. HAFSTAD. Zero, at the present time.

Senator THYE. But I mean once you have spent the $60 million.

Dr. HAFSTAD. In the reactor of the design we hope to develop, the total heat would be converted at about, say, 25 percent conversion efficiency into electrical energy, because in any conversion plant, coal or oil or otherwise, you have to generate about four times as much heat as you actually get out as electrical energy, and so you take any one of these production reactors and determine the size of it by the amount of materials that you want to produce, and calculate the heat that is generated, and take a fourth of that and that would be roughly the electrical power which could be extracted. This seems to be worth doing because the amounts of energy here are really very high, and this is the sort of thing we are struggling with in the reactor development program at the present time.

Senator THYE. Well, it is worthy of an experimental project because you are in the field of research all of the way through there.

ELECTRICAL DISTRIBUTION

Dr. HAFSTAD. Very definitely; yes. Now, the next step is this: Since we will be involved in large amounts of electrical power, we will have to tie in to electrical distribution systems, so we have brought in four different groups of industrial and utility companies, to begin at this time studying ways and means whereby such interests could be tied to our production interests and study ways of distributing and selling and therefore getting credit for this byproduct electric power.

This is a very interesting and promising development. It may take years to complete successfully, but, at least we are getting started on it and it is a step in the direction of trying to reduce the total costs of the project.

Now, then, we have already inserted pages 171 to 179 in the record. I thought perhaps it would be helpful to you gentlemen if I gave you the big changes, rather than go into detail on this. Because you would like to see what else is going on in this field I think we should insert in the record the unclassified construction items pages 816 and 817, to complete the record.

Senator MAYBANK. Those will be inserted in the record if there is no objection.

(The information referred to is as follows:)

DETAILED JUSTIFICATION OF CONSTRUCTION

Reactor development construction

	1951 actual	1952 estimate	1953 estimate
Cost obligated	$52,556,879	$50,147,317	$44,100,000
Cost incurred	54,820,304	48,500,000	67,000,000

GENERAL

The reactor development program not only develops certain new and novel types of reactors, it also constructs those reactors and operates them. To accomplish the full responsibilities of the program it was necessary (1) to construct and equip laboratories capable of handling the specialized problems of reactor development; (2) to construct and equip plants to manufacture reactor-grades of reactor materials such as beryllium and zirconium because there is as yet no appreciable commercial market for these materials and because the production is not yet on a routine basis; (3) to construct and equip chemical processing plants for the processing of spent fuels, treatment of waste products and other purposes; and (4) to establish a reactor testing station, where the hazards associated with reactor experiments could be reduced to a minimum.

The construction program in 1953 is primarily for building reactors, which requires 84 percent of the 1953 estimate as follows: (1) for completion of reactors under construction, $12,811,006; (2) for starting new reactors, $23,000,000; (3) for facilities for reactor experiments and reactor modifications, $1,275,000; (4) for a total of $37,086,006. The balance, $7,125,000, provide $2,415,400 more for the chemical plant at the Reactor Testing Station, Arco, Idaho, and $3,631,379 for several pilot plants in which to study chemical processes, and for alterations at new and existing facilities; and $967,615 for restoration of leased laboratory premises at the University of Chicago and Palos Park, Ill.

A brief analysis of the purposes for which construction funds have been obligated is as follows:

	1951 actual	1952 estimated	1953 estimated
1. Reactors, reactor experiments and closely related facilities	$27,096,904	$36,687,298	$37,086,006
2. Chemical processing plants and material production plants	17,473,783	8,963,905	4,044,400
3. Laboratories and supporting facilities	5,208,140	3,103,936	2,839,594
4. Reactor testing station, central facilities	2,778,052	1,392,178	130,000
Total	52,556,879	50,147,317	44,100,000

The work will be conducted by the following administrative areas:

	1951 actual	1952 estimated	1953 estimated
Argonne Laboratory, Du Page County, Ill	$620,885	$785,593	$1,993,920
Pittsburgh Laboratory, Pittsburgh, Pa	23,025,988	17,530,614	5,000,000
Reactor testing station, Idaho Falls, Idaho	23,630,768	11,969,598	2,906,406
Knolls Laboratory, Schenectady, N. Y	2,805,712	18,811,100	7,900,000
Oak Ridge Laboratory, Oak Ridge, Tenn	2,256,001	764,000	620,674
Mound Laboratory, Dayton, Ohio	0	0	155,000
New York area	217,525	286,412	174,000
New projects, not yet assigned to areas:			
New reactors and reactor experiments	0	0	23,700,000
Plant alterations	0	0	750,000
Chemical process pilot plant	0	0	900,000
Total	52,556,879	50,147,317	44,100,000

Nuclear Research Program

STATEMENT OF DR. THOMAS H. JOHNSON, DIRECTOR, DIVISION OF RESEARCH, UNITED STATES ATOMIC ENERGY COMMISSION

JUSTIFICATION

Senator Maybank. Will you present the next witness?

Mr. Boyer. The next witness is Dr. Johnson who will speak to the research program. This is the first time that Dr. Johnson has appeared before the committee. He is the Director of our Research Division.

Senator Maybank. For the sake of saving some time, what pages would you suggest should be put into the record, on the research program that would not be classified? It starts on page 251, is that right?

Mr. Boyer. I would suggest pages 251 through 322 since the operating program is detailed on those pages.

Senator Maybank. How about the construction items?

Mr. Boyer. Yes; they could also go in, pages 851 to 858.

Senator Maybank. Without objection those pages will be placed in the record. Dr. Johnson, will you proceed?

(The information referred to is as follows:)

Operating Program Summary and Narrative Statement

Physical research program

	1951 actual	1952 estimate	1953 estimate
Isotope development, production, and distribution	$850,978	$643,000	$600,000
Research and development:			
Physics	16,614,039	17,752,101	20,981,000
Chemistry	9,790,582	13,017,381	14,791,000
Metallurgy and materials	3,078,114	4,480,118	5,624,000
Mathematics and computations	140,795	149,000	100,000
University training and cooperation	961,056	1,224,000	1,004,000
Undistributed costs (operating time of accelerators, research reactors, etc., not distributed to programs)	53,354		
Total accrued costs	31,488,918	37,265,600	43,100,000

The physical research program implements those provisions of the Atomic Energy Act of 1946 which direct the Commission to assist and foster private research and to conduct research and development in its own laboratories, thus assuring the Government of adequate scientific and technical accomplishment in the field of atomic energy. Activities falling within the research program have been initiated because of their directly foreseeable bearing upon the development of means for producing and utilizing atomic energy and its byproducts. These activities include (*a*) basic research in directly related fields as enumerated in the act, (*b*) investigations for acquiring knowledge directly applicable to practical problems arising in the atomic energy program, and (*c*) activities which help to provide a continuing supply of scientifically trained specialists essential to the accomplishment of the program.

Much of the basic research and affiliated training activities is carried on in university laboratories with only a fraction of the costs being borne by the Federal Government. Nevertheless, these activities have immeasurably strengthened America's position with respect to atomic energy and many directly applicable results have accrued to the benefit of the program. The Commission's fiscal year 1953 budget estimate provides $9.6 million or an increase of $0.9 million over fiscal year 1952 for such private research activities. It is most certainly to the Nation's advantage to provide its best research scientists with such facilities and assistance as will improve the quality and volume of their contributions,

and on these grounds both the amount and the increase in the budget estimate are readily justifiable.

In attempting to meet the applied research needs of an expanding weapons program, university and other private laboratories are being invited to direct their investigations on an expanding scale, and with Government support, toward practical problems arising in the Commission's program. As compared with the alternative of expanding staff and facilities in the Commission's laboratories, this policy is netting substantial economies while, at the same time. broadening the base of research activity available to the Commission in case of emergency. The budget estimate for fiscal year 1953 will provide $5.4 million for such off-site applied research or an increase of $2.7 million over fiscal year 1952.

Some basic research and the principal load of applied research is carried on in the laboratories of the Commission. The latter work is directed toward acquisition of information needed for improvement of processes for production of fissionable material, for improvement of weapons, and for the development of new reactors. The budget estimate provides $27.9 million in fiscal year 1953 for support of physical research, both basic and applied, in the Commission's laboratories which is $2.2 million above that for fiscal year 1952.

Detailed Justification of Operating Costs

PHYSICAL RESEARCH PROGRAM, PRODUCTION SUBPROGRAM

Isotopes category

Activity	1951 actual	1951 estimate	1953 estimate
Radioisotopes, net	$16,335	$13,000	----------
Stable isotopes, net	530,892	380,000	380,000
Research and development, radioisotopes	303,751	250,000	220,000
Total accrued costs	850,978	643,000	600,000
Radioisotopes, net	16,335	13,000	----------
Production, gross	910,991	1,175,000	1,220,000
Deduct:			
Distribution credits	455,584	500,000	510,000
Sales	439,072	662,000	710,000

During fiscal year 1951 and fiscal year 1952 radioisotope production was expanded to meet increasing demands for research, medicine, and industry applications. The number of shipments increased almost 40 percent during fiscal year 1951 and 20 percent during fiscal year 1952. An increase of 8 percent is estimated for fiscal year 1953.

A new program was instituted in fiscal year 1951 to provide isotopes to civil defense training groups without charging for the cost of production. This program will continue at a $10,000 level in fiscal year 1952 and fiscal year 1953. In fiscal year 1952 the net cost of $13,000 is due to the stockpiling of carbon–14 labeled compounds procured in bulk quantities from private laboratories for future sale in smaller lots

During fiscal year 1951 approximately 5 percent of total sales were made to industrial firms. This percentage is about double the volume of similar sales made in fiscal year 1950. It is estimated that sales to industrial concerns will amount to nearly 10 percent of 1952 sales and 15 percent by fiscal year 1953.

In computing costs of radioisotope production the Commission has included only the incremental costs and omitted research and development costs and plant amortization. These latter costs have been omitted from the pricing structure for two reasons. First, the research work and the facilities were necessary for work in which the Commission is concerned directly; and second, radioisotope prices were established on the basis of marginal costs in order to encourage their use in research, medicine and industry and to increase knowledge and experience which would lead to wider applications of the peacetime uses of atomic energy.

The Commission, in August, completed negotiations with the Stanford Research Institute to make a study of the economics of radioisotope production and distribution. This study is to include an evaluation of industrial cost and pricing policies and their application to the Commission's isotope distribution program.

Industry has been slow to participate in the development of uses for radioisotopes and the uses already made have been in the areas of research and development rather than large scale application. It has, therefore, not been feasible to

have a different price schedule for industrial uses as distinguished from research or medical use. If a large industrial use of a radioactive material should develop, the cost and price situation will be reviewed. Conceivably the unit price of a given radiomaterial might be reduced rather than increased if a routine, high-level production schedule were maintained.

Private industry will probably not be interested in taking over the production and distribution of radioisotopes within the next 5 years. The Bendix Aviation Corp. and Tracerlab, Inc., have shown considerable interest in this field and are currently performing for the Commission, at no cost to the Government, surveys of the feasibility of private ownership and operation of reactors for radio isotope production. Another possibility is that of changing from a "retail" to a "wholesale" method of distribution and providing only the manufacturing facilities for the production of basic unprocessed irradiated (radioactive) materials.

Stable isotopes (net):

1951 actual	$530, 832
1952 estimate	380, 000
1953 estimate	380, 000

During fiscal year 1951 the stable isotope production program made available 89 different isotopes to various laboratories on a loan basis—11 of the 89 for the first time.

During fiscal year 1952 the program is being reduced. Production time will be devoted to inventory replenishment and the production of specific isotopes in quantities to satisfy special requirements.

In fiscal year 1953 the program level will be maintained at the same level established in fiscal year 1952. Selective replenishment of the inventory and the production required to meet special requirements will be continued.

Research and development—radioisotopes:

1951 actual	$303, 751
1952 estimate	250, 000
1953 estimate	220, 000

Radioisotope research and development is carried out by both the Commission-operated Oak Ridge National Laboratory and through cost-type development contracts administered by the Isotope Division of the Commission.

The Oak Ridge National Laboratory activity provides the essentials required for improvement of radioisotope production and separation processes. During fiscal year 1952 the work is centered on development of methods for improving strontium–90 production, design of facilities for handling high activity cobalt–60 sources, development of an extraction process whereby carbon–14 in a simple molecule will be obtained directly from pile-irradiated beryllium nitride, and completion of work on a process for the recovery of beryllium from irradiated beryllium nitride. In fiscal year 1953 the work is expected to center around routine improvements in existing processes, production of ultrapure target materials, continuance of work on direct production of carbon–14 labeled compounds, and investigations relative to use of high vacuum, high temperature distillation for radioisotope purification.

Several small development contracts which are administered by the Isotopes Division, have increased the number of isotope-labeled compounds available for physical, biological, and medical research. Because of the progress made, continued support of the activity during fiscal year 1953 will not be necessary and no estimate of cost is included. In fiscal year 1952 a reduced level will permit the development of a few unique compounds which are of particular interest and are not presently available from commercial sources.

Physics research category

Activity	1951 actual	1952 estimate	1953 estimate
Basic physics research	$13, 531, 196	$14, 736, 775	$16, 716, 000
Applied physics research	3, 082, 843	3, 015, 326	4, 265, 000
Total accrued costs	16, 614, 039	17, 752, 101	20, 981, 000

The purpose of the research activities in the physics category is (1) to encourage maximum scientific progress, (2) to provide adequate information in fields of physics related to atomic energy to serve as a basis for continued technological

advances in the future, and (3) to contribute to immediate problems of the Commission when required.

During fiscal year 1952 and fiscal year 1953 approximately one-half of the total operating cost of the physical research program represents cost of research in physics. The major reason for this distribution of effort is the fact that the fundamental problems which limit the understanding of the atomic nucleus, and hence the ability to predict and control nuclear reactions, are problems in the field of physics. For this reason, the preponderant effort in physics has been in basic physics, both fundamental and exploratory.

The total effort of the Atomic Energy Commission in physics is not commensurate with the need for scientific and engineering data in the expanding atomic energy field, but further increase is limited by availability of facilities and nuclear machines, and the competition for scientific manpower with other research and development efforts. These estimates are, therefore, a measure of what can actually be accomplished, rather than a minimum requirement of research effort.

Although, traditionally, basic research has been carried out largely in private institutions, an appreciable portion (60 percent in fiscal year 1952) of the physics basic research program is carried on in laboratories of the Commission. The following are the dominating factors in determining the character of research in Commission-operated laboratories, and in general apply to other categories as well as to physics:

1. Certain areas of basic knowledge in physics are necessarily related primarily to the atomic energy program and must be explored more rapidly than could be expected in university programs.
2. Research which is directly related to the development of atomic weapons and atomic power necessarily involves restricted data and often involves health hazards, and must therefore be carried on in remote, excluded areas.
3. Some essential basic research in physics requires large installations and equipment which are beyond the means of a single university to build or maintain.

The principal increase in physics research (both basic and applied) is in the work carried out through contract with public and private institutions. During fiscal year 1951, 33 percent of the physics research cost was incurred in off-site research contracts, 36 percent is estimated during fiscal year 1952 and 39 percent during fiscal year 1953.

During fiscal year 1952 the total physics research cost in Commission-operated laboratories increased approximately 2 percent above the fiscal year 1951 cost. In total this is largely the result of wage and price increases; the cost of new projects initiated having been compensated by reductions in program elsewhere. For fiscal year 1953, an increase of about 11 percent is estimated, which results largely from utilization of nuclear machines which are to be completed in fiscal year 1952.

	1951 actual	1952 estimate	1953 estimate
Basic physics research	$13,531,196	$14,736,775	$16,716,000
Ames Laboratory	266,194	229,080	250,000
Argonne National Laboratory	1,105,630	1,358,603	1,550,000
Berkeley Radiation Laboratory	2,793,517	3,116,552	4,103,000
Brookhaven National Laboratory	2,698,810	2,832,200	2,900,000
Chicago area	115,988		
Oak Ridge National Laboratory	1,329,181	1,097,726	1,060,000
Washington area	5,221,876	6,102,614	6,853,000
Ames Laboratory	266,194	229,080	250,000
Scientific man-years	19	16	16

The research program in basic physics at the Ames Laboratory was reduced in scope during fiscal year 1952 with the assignment of approximately 3 scientific man-years to applied physics work. During fiscal year 1952 and fiscal year 1953 the costs are based on an estimated 16 scientific man-years with an estimated increase of approximately $21,000 in fiscal year 1953 costs for this activity. This increase results from a general increase of total costs at Ames primarily as a result of occupancy of the research building.

The following research programs are under way at Ames, and will be continued in fiscal year 1953.

1. Gamma and beta ray spectroscopy; studies of nuclear energy levels.
2. Synchrotron experiments in the 20–70 MEV range.
3. Solid state and low temperature physics.
4. Experimental and theoretical studies of the fission process.

	1951 actual	1952 estimate	1953 estimate
Argonne National Laboratory	$1,105,630	$1,358,603	$1,550,000
Scientific man-years	33.0	38.1	43.0

During fiscal year 1951 the effort of the physics division at the Argonne National Laboratory on the physics research program was reduced by the urgent requirements for reactor development on the Savannah River reactors. During fiscal year 1952 the physics effort is being substantially increased and will be increased further during fiscal year 1953. The new research reactor at the Argonne Laboratory is being completed in fiscal year 1952 and the increase in technical effort has been made to assure maximum utilization of this facility.

The program in physics is concerned primarily with the development of theory and experiments aimed at obtaining a better understanding of nuclear structure. Because of the intense neutron beams available from the reactors at the Argonne National Laboratory, their concern is primarily with the interactions involving the neutron. Improved measurements on the neutron-proton interaction have been carried out and a careful determination of the neutron-electron interaction is in progress. It is planned to measure the effect of magnetic orientation on the interaction between elementary particles or use of polarized neutron beams and other techniques. An increased effort will be made in the measurement of slow and fast neutron cross sections and inelastic neutron scattering.

	1951 actual	1952 estimate	1953 estimate
Berkeley Radiation Laboratory	$2,793,517	$3,116,552	$4,103,000
Scientific man-years	69	65	73

The University of California Radiation Laboratory program is devoted largely to basic nuclear physics, with particular emphasis on the large accelerators as a tool for exploration. In the past, high-energy particles produced by these accelerators have provided the most useful means of exploring the nucleus. The increased effort of approximately 8 man-years during fiscal year 1953 results primarily from completion of the bevatron. The increased cost in fiscal year 1953 also is due to (1) the cost of bevatron operation and (2) reallocation of fixed charges formerly chargeable to programs other than physical research. The program activities which are under way in fiscal year 1952 and which will be continued in fiscal year 1953 are—

1. Investigation of the nuclear forces through studies of scattering of fundamental particles.
2. Study of the properties of various types of mesons and investigation of their roles in nuclear structure.
3. Experiments on the nuclear disintegrations and transformations produced by high-energy particles and X-rays.
4. Development of techniques for the detection and measurement of properties of high-energy particles and photons.
5. Studies of shielding and development and application of new, high-speed, high-resolution electronic circuits.

	1951 actual	1952 estimate	1953 estimate
Brookhaven National Laboratory	$2,698,810	$2,832,200	$2,900,000
Scientific man-years	82.4	84.9	97.4

The increased effort in scientific man-years at the Brookhaven National Laboratory results in very little change in cost level during fiscal year 1953. During fiscal year 1951 and fiscal year 1952 basic physics carried the major share of reactor operations cost since these researches constituted the major fraction of reactor usage. The fiscal year 1953 cost estimate predicts a decrease in basic physics cost for reactor usage, but results in a net increase due to start up of the cosmotron program.

The research program in basic physics includes studies of—

1. Dynamical properties of nuclei.
2. Stationary properties of nuclei.
3. Solid state physics and radiation damage.
4. Physics of high energy particles.
5. Accelerator development.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$1,329,181	$1,097,726	$1,060,000
Scientific man-years	44.5	50.0	48.0

The level of effort in basic physics at the Oak Ridge National Laboratory increased during fiscal year 1952 because of the addition to the Oak Ridge National Laboratory staff of personnel in theoretical physics and accelerator operation. A slight reduction is expected in fiscal year 1953. The continuing basic physics studies include:

1. Neutron diffraction.
2. Neutron diffraction, polarization, and magnetic scattering.
3. Scintillation spectrometry and the development of fast counting techniques.
4. Theoretical nuclear physics.
5. Beta-ray spectroscopy and the analysis of decay schemes.

	1951 actual	1952 estimate	1953 estimate
Washington area	$5,221,876	$6,102,614	$6,853,000
AEC–ONR joint program	3,247,798	2,800,000	3,126,000
Other off-site research	1,974,078	3,302,614	3,727,000

Basic physics research in the Washington area includes the joint program with the Office of Naval Research and a program of research in private and public institutions, which is carried out under contracts administered by the operations offices of the Atomic Energy Commission.

It is contemplated that the joint AEC-ONR program eventually will level off at an annual total cost of $5.6 million of which AEC support will be $2.8 million. The cost estimated for fiscal year 1953 at $3.1 million anticipates a $0.3 million reduction of working capital balances. Following is a listing of institutions and the work being done by each under the program:

Bartol Research Foundation	Cosmic ray showers and counters.
California Institute of Technology	Cloud chamber cosmic ray studies.
Do	Energy levels in light nuclei.
California, University of	Mesons and showers.
California, University of, at Los Angeles	Proton range-energy studies.
Chicago, University of	High energy primary interactions.
Do	High energy proton studies.
Columbia University	Do.
Cornell University	Photon-meson reactions.
Duke University	Cosmic ray stars.
Harvard University	High energy particle interactions.
Illinois, University of	Nuclear distintegration schemes.
Indiana, University of	Beta and gamma spectra.
Kansas, University of	Precision proton reactions.
Massachusetts Institute of Technology	Nuclear energy levels and radioactivity.

Michigan, University of	Cosmic ray showers and penetrating particles.
Do	Beta and gamma spectra.
Minnesota, University of	Heavy particle component.
Do	Precision particle scattering.
National Research Council	Nuclear science standards.
Notre Dame, University of	Low energy levels.
New York University	Relative neutron intensities.
Pennsylvania, University of	Beta and gamma ray studies.
Pittsburgh, University of	Precision particle scattering.
Princeton University	Meson energy spectra, stars and bursts.
Puerto Rico, University of	Meson studies at low altitudes.
Rutgers University	Nuclear moments.
Stanford University	Billion volt electron reactions.
Do	Nuclear moments.
Southern California, University of	Beta ray spectroscopy.
George Washington University	Short lifetimes.
Washington, University of	Meson momenta and positive excess.
Washington University	Meson production and disintegration.
Do	Nuclear spectra and shell structure.
Yale University	Atmospheric showers structure.
Do	Precision electron reactions.
Do	Energy levels, high speed counting techniques.
Do	Theory of nuclear structure.

The remainder of the basic physics program in the Washington area is carried out through direct contract between field offices of the Commission and private and public institutions. The total cost of these contracts is estimated to increase from $3,302,614 during fiscal year 1952 to $3,727,000 in fiscal year 1953. This increase of $424,386 has been recommended as the minimum which is appropriate, in view of the expansion of applied research throughout AEC operations, and is thought to be compatible with the limited availability of scientific personnel and physical facilities available in research institutions. The total increase will be required to provide for projected increases of work presently under contract. This includes increases for new machines coming into use and for increases to fully utilize personnel and facilities at institutions where research is currently under way. Following is a listing of institutions performing research under this program:

Contractor	Short title	1951 actual	1952 estimate	1953 estimate
Alabama Polytechnic Institute	Research with mass spectrometer	$5,000	$6,000	$7,500
Brown University	500 KEV Cockroft-Walton	6,190	14,000	15,000
California Institute of Technology.	Operation and experimentation—1 BEV synchrotron.	2,335	230,000	297,665
Carnegie Institute of Technology	Nuclear research using 400 MEV cyclotron.	176,144	540,000	550,000
Case Institute of Technology	Study of gamma ray spectrums produced from a 30 MEV bevatron.	62,113	96,250	80,000
Columbia, University of	Determination of nuclear moments and masses by micro waves spectroscopy.	26,000	29,000	29,000
Do	Studies and investigations in nuclear physics.	382,688	400,000	550,000
Connecticut, University of	Mass spectrographic analysis of geiger counter cases.	12,000	14,000	15,000
Duke University	Nuclear physics project using electrostatic generator.	15,151	95,000	100,000
Florida, University of	Electrostatic generator program	2,000	5,000	7,400
High Voltage Engineering Corp.	Patent rights for Van de Graaff generators.	3,250	----------	----------
Iowa, State University of	Research with electrostatic generator	30,000	31,000	45,000
Johns Hopkins University	Spectroscopy of hydrogen isotopes	19,960	16,500	7,100
Do	Research in field of nuclear reactions	18,490	16,000	18,000
Do	Neutron angular distribution measurements.	10,179	6,500	7,500
Do	Lifetime study of nuclear states	13,562	8,600	9,000
Do	Studies of nuclear reactions and energy levels.	10,000	21,000	22,000
Kansas State College	Precision beta-ray spectrometry	----------	7,000	8,500
Michigan, University of	300 NEV racetrack synchrotron	26,887	90,000	100,000
Do	42 inch cyclotron program	33,480	30,000	35,000
Minnesota, University of	Operation of 50 MEV ion accelerator	----------	----------	225,000

Contractor	Short title	1951 actual	1952 estimate	1953 estimate
Nebraska, University of	Study of range-energy relation for slow ions.	$10,000	$14,500	$12,000
New York University	Cosmic ray research	19,993	22,000	22,000
North Carolina, University of	Absolute intensities of cosmic radiation.	23,000	25,000	25,000
Do	Nuclear disintegration in photographic emulsions.	7,000	8,000	8,000
Northwestern University	Use of photographic emulsions enriched with Li^6.	27,036	25,000	27,000
Ohio State University	Low temperature physics and nuclear paramagnetism.	15,375	28,125	23,000
Do	Modification of 42-inch cyclotron	10,000	19,000	19,000
Do	Research with Van de Graaff generator.	----------	22,000	25,000
Oregon State College	32-inch cyclotron program	9,488	11,000	14,000
Pennsylvania, University of	Collins cryostat	15,000	16,500	16,500
Princeton University	Transport phenomena in ionized gases	3,000	7,000	7,000
Do	Nuclear research using 17 MEV cyclotron.	205,261	200,000	250,000
Puerto Rico, University of	Low latitude cosmic ray studies	12,723	14,484	18,135
Purdue University	Electron accelerator for nuclear physics investigations.	11,500	34,000	27,000
Do	Research in nuclear reactions with fast alpha particles, deuterons and neutrons.	19,500	59,750	54,000
Do	Research with synchrotron	32,250	80,750	80,000
Do	Research with cyclotron	9,605	30,895	----------
Reed College	Investigation of K. and L. capture X-radiation.	7,125	12,650	10,000
Rensselaer Polytechnic Institute.	High speed coincidence circuits and beta-ray spectroscopy.	10,000	25,000	25,000
Rochester, University of	Research in high-energy particle physics.	428,932	557,000	557,000
St. Louis University	Investigations of beta decay at low energies.	6,650	7,300	6,000
Syracuse University	Cosmic ray research	4,350	17,980	10,000
Texas, University of	Operation of 4 MEV electrostatic generator.	27,509	66,860	58,000
Vanderbilt University	Mass spectrograph research in beta and gamma ray spectroscopy on decay schemes of radioactive isotopes.	7,800	9,000	9,000
Do	Nuclear research with "Ranger"	----------	16,500	18,000
Washington, University of	60-inch cyclotron program	48,750	116,250	75,000
Do	Establishment of cryogenic laboratory	5,000	7,000	----------
Washington, State College of	Nuclear magnetic resonance in liquid solutions.	----------	5,000	4,000
Wesleyan University	Improvement of spectrograph measurement of isotopic ration for various substances.	13,455	2,781	----------
Wisconsin, University of	Low temperature physics	6,490	15,245	14,700
Do	Nuclear research program	63,000	88,900	100,000
Do	Theory of very light nuclei	5,700	8,700	8,000
Wyoming, University of	Measurement of relaxation times of nuclei.	6,500	9,500	8,000
Yale University	Isotope separation and related topics	16,157	13,094	18,000
California, University of (ONR)	Low temperature research	----------	25,000	----------
California Institute of Technology (ONR).	Gamma ray spectroscopy	8,000	25,000	50,000
Wisconsin, University of (ONR)	Ultrasonic investigations	7,500	----------	----------
Yale University (ONR)	Special purchases in connection with linear electron accelerator.	15,000	----------	----------

	1951 actual	1952 estimate	1953 estimate
Applied physics research	$3,082,843	$3,015,326	$4,265,000
Ames Laboratory	----------	71,390	75,000
Argonne National Laboratory	176,918	358,252	750,000
Berkeley Radiation Laboratory	472,216	550,000	250,000
Brookhaven National Laboratory	962,915	407,400	500,000
Oak Ridge National Laboratory	1,437,736	1,456,104	1,390,000
Washington area	33,058	172,180	1,300,000
Ames Laboratory	----------	71,390	75,000
Scientific man-years	----------	5.0	5.0

During fiscal year 1952 work in applied physical measurement and in instrument development and construction have been established as new projects. Although their purpose is to contribute a service to the other projects at the laboratory, the service is not direct or limited enough to permit reasonable allocation of costs to these projects. The total physics effort at Ames has not increased as a result of the establishment of this activity. The increase in costs during fiscal year 1953 results from a general increase of total costs at Ames primarily as a result of occupancy of the research building.

Detailed justification of operating costs

	1952 actual	1952 estimate	1953 estimate
Argonne National Laboratory	$176,918	$358,252	$750,000
Scientific man-years	6.5	12.7	21.1

The applied physics program of the Argonne National Laboratory is directed primarily toward obtaining the fundamental scientific information upon which reactor engineering studies can be based.

During fiscal year 1951, additional information pertinent to shielding was obtained from the study of prompt neutron and gamma reactions. Velocity selector equipment, resonance detectors, the Van de Graaff generator, and the deuterium and tritium neutron sources were used in these investigations. Crystallographic investigations pertaining to the effects of irradiation on graphite and other materials were extended. Several important cross sections were measured by mass spectrographic techniques.

The effort on this program will be increased in fiscal year 1952 and fiscal year 1953. Further neutron, gamma, and neutron scattering measurements will yield additional constants necessary for shield development. The work on cross-section measurements with the neutron chopper technique will be emphasized. Emphasis will also be placed on obtaining more accurate values of the nuclear constants of fissionable isotopes. As in the case of Ames Laboratory, the work on instrument development has been established as a new project instead of spreading the cost unrealistically to other projects at the laboratories. The costs for this project, $125,000 during fiscal year 1952 and fiscal year 1953 have not increased the total laboratory effort.

	1951 actual	1952 estimate	1953 estimate
Berkeley Radiation Laboratory	$472,216	$550,000	$250,000
Scientific man-years	5	10	6

Please refer to the classified portion of the justifications for information concerning this estimate which appears on page 323.

	1951 actual	1952 estimate	1953 estimate
Brookhaven National Laboratory	$962,915	$407,400	$500,000
Scientific man-years	15.4	10	15

In fiscal year 1951 the major efforts were devoted to the start-up and evaluation of the performance of the Brookhaven reactor. Extensive information concerning its parameters and behavior has been obtained for application to similar reactors. Completion of this work in fiscal year 1951 is responsible for the reduction of cost levels for ensuing years.

During fiscal year 1951 the neutron physics program consisted primarily of equipment construction. Measurements are now in progress using reactor neutrons. A comprehensive program of measurement of neutron cross sections as a function of energy for elements of particular interest in weapons, reactors, and reactor shields will be carried out using a variety of neutron spectrometers and other special detectors. Two time of flight instruments utilizing mechanical shutters to interrupt neutron beams from the reactor will covery energy ranges up to 100 volts and a few thousand volts respectively. An all-electric spectrometer

will be used for similar measurements with the cyclotron; for very low energies, a double crystal neutron spectrometer will be used in connection with the reactor; at energies above 10,000 volts, precisely controlled homogeneous neutron beams will be derived from proton bombardments on lithium or other targets utilizing the Van de Graaff generator. The slow chopper and crystal spectrometer are in use at the reactor. The Van de Graaff is also in use.

The work will be expanded during fiscal year 1953 with increased use of the existing equipment and with the cyclotron neutron time of flight equipment and the reactor fast chopper. All equipments will be in full use during the year making measurements on materials of most interest in the field of cross-section determination.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$1,437,736	$1,456,104	$1,390,000
Scientific man-years	65.6	61.5	57.

Major projects included in applied physics during fiscal year 1952 at Oak Ridge National Laboratory include production and separation of several isotopes of programmatic interest to the Commission, electromagnetic separation methods, accelerator development, isotopic analysis methods, preliminary design of a research reactor, and neutron cross section measurement. With some changes in immediate objectives, these projects will be continued through fiscal year 1953 with the exception of the design of a research reactor.

	1951 actual	1952 estimate	1953 estimate
Washington area	$33,058	$172,180	$1,300,000

The applied physics program of the Washington area consists of research assigned to public and private institutions in the fields of direct interest to the production, weapons, and reactor programs. The tremendous expansion of the production and other programs of the Commission, which began in fiscal year 1950, presented new research problems. Some of this expansion in research activity has been accomplished by adding to the staff of Commission laboratories. Wherever possible short-term research jobs will be assigned to the off-site program so as to keep to a minimum the building of new facilities which might commit the Commission to support research operations in excess of its long-term needs. Following is a list of institutions assigned work under this program:

Location	Short title	1951 actual	1952 estimate	1953 estimate
H. K. Ferguson Co.	Consultant services		$3,000	
High Voltage Eng. Corp.	Patent rights for Van de Graaff generators.	$3,250		
Johns Hopkins University	Fast neutron cross-section measurements.		15,000	$55,000
Massachusetts Institute of Technology.	Echelle spectroscopy		17,000	50,000
National Bureau of Standards	Applied physics research		15,000	77,280
Nuclear Development Association.	Fast neutron data		8,580	35,000
Princeton University	Theoretical research on interactions of light elements.		25,000	150,000
Rice Institute	Nuclear physics of the light elements		22,600	50,000
Baird Associates (ONR)	Tunable polarization filters	12,500	12,000	15,000
Bartol Foundation (ONR)	Development of techniques and measurements in the field of inelastic neutron scattering.	17,808	25,000	30,000
Westinghouse (ONR)	Research in neutron physics		29,000	35,000
Projects to be named (for new off-site contracts and for assignment of new projects to Commission-owned installations in the fields of cross-section measurements and new physical methods for separation of isotopes of interest to the Commission).				802,720

Chemistry research category

Activity	1951 actual	1952 estimate	1953 estimate
Basic chemistry research	$6,170,753	$7,545,654	$7,828,000
Applied chemistry research	3,619,829	5,471,727	6,963,000
Total accrued costs	9,790,582	13,017,381	14,791,000

Changes in the total chemistry research effort reflect the changes in the production and reactor program goals. Emphasis has been increased on raw materials chemistry, processes for the separation of plutonium and recovery of uranium, thorium extraction and breeder studies, and the chemical separation of isotopes of programmatic interest to the Commission. Reactor development in the fields of certain types of reactors has led to increased effort in high temperature chemistry and the study of the radiation effect on compounds and solutions. The combination of these program changes results in a cost increase during fiscal year 1952 of approximately $3.2 millions and an expected increase of fiscal year 1953 of about $1.8 millions. Basically, these increases arise from new requirements in the applied chemistry field which have, to some extent, produced comparable increases in basic chemistry research aimed at providing fundamental knowledge of the chemical processes involved.

	1951 actual	1952 estimate	1953 estimate
Basic chemistry research	$6,170,753	$7,545,654	$7,828,000
Ames Laboratory	488,866	488,520	530,000
Argonne National Laboratory	1,612,742	1,411,367	1,465,000
Berkeley Radiation Laboratory	1,222,547	1,380,000	1,388,000
Brookhaven National Laboratory	881,712	1,301,800	1,385,000
Oak Ridge National Laboratory	1,017,813	1,317,914	1,260,000
Washington area	947,073	1,646,053	1,800,000

The major change in basic chemistry research has been the increased activity in radiation chemistry. In some of the laboratories, programs have been appreciably reoriented as a result of new production goals of the Commission, new reactor projects, and clearer recognition of their associated chemistry problems. While effort within the major laboratories has fluctuated, the total cost of basic chemistry research in the laboratories for fiscal year 1952 has increased about 12 percent, which is accounted for primarily by wage and price increases. A major portion of the fiscal year 1952 cost increase has resulted from expansion of the off-site research program. During fiscal year 1953 the total cost increase is about $0.3 million.

Research

	1951 actual	1952 estimate	1953 estimate
Ames Laboratory	$488,866	$488,520	$530,000
Scientific man-years	37.5	39.8	39.8

The basic chemistry research at Ames includes physical and inorganic chemistry and radiochemistry, and structure analysis of elements and compounds by X-ray diffraction. Elements of particular interest are thorium, the rare earths, zirconium, and various radioactive nuclear species. Also included in basic study of chemical and spectrographic analytical methods. A slight increase in staff and costs was made during fiscal year 1952. Operation at the same level during fiscal year 1953 is planned. The increased cost in this activity during fiscal year 1953 is the result of a general increase of total costs at Ames primarily as a result of occupancy of the Research Building.

	1951 actual	1952 estimate	1953 estimate
Argonne National Laboratory	$1,612,742	$1,411,367	$1,465,000
Scientific man-years	46.2	44.4	42.6

The basic chemistry program at Argonne is devoted largely to the heavy radioactive elements, including actinium and protactinium; a few radioisotopes of light elements, He^3 and tritium; and studies of radiation effects on solids and solutions. Reduction in manpower estimates during fiscal year 1952 and fiscal year 1953 results from the expectation of lesser manpower availability for basic research. The increased cost in fiscal year 1953 results from provision of general periodic increases in salary and the allocation of cost of operation of the CP–5 reactor, to be completed about the beginning of fiscal year 1953, which will increase costs slightly for this activity during fiscal year 1953.

Detailed justification of operating costs

	1951 actual	1952 estimate	1953 estimate
Berkeley Radiation Laboratory	$1,222,547	$1,380,000	$1,388,000
Scientific man-years	67	68	71

The basic chemistry research at the University of California Radiation Laboratory includes the study of (1) high energy reactions and their radioactive products using the 184-inch and 60-inch cyclotrons, (2) new isotopes of the heavy elements and the transuranic elements, (3) high temperature chemistry of materials of interest in reactor operation, and (4) research in the development of techniques and special equipment required for radiochemistry.

The general cost increase for fiscal year 1952 has been partially offset by an indirect adjustment of $55,000. A small increase in research personnel is contemplated in fiscal year 1953, with completion of certain phases of work under other programs.

	1951 actual	1952 estimate	1953 estimate
Brookhaven National Laboratory	$881,712	$1,301,800	$1,385,000
Scientific man-years	35.0	50.0	58.5

The basic chemistry research at the Brookhaven National Laboratory includes studies of elements in the vicinity of uranium, the fission products, radiation chemistry, tracer studies of chemical reactions, synthesis of complex organic molecules with radioactive elements, and characterization of radioactive nuclei produced in the major nuclear machines.

Staff increases made during fiscal year 1952 permit further exploitation of the reactor and utilization of other machines. A further increase of about 8 man-years is contemplated in fiscal year 1953.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$1,017,813	$1,317,914	$1,260,000
Scientific man-years	39.8	49.3	48.3

The Oak Ridge National Laboratory basic chemistry program includes inorganic chemistry of the heavy elements, nuclear chemistry, isotope separations, high temperature reactions, and radiation chemical studies of organic systems and of solutions.

The increase of approximately 10 man-years during fiscal year 1952 represents a major increase in basic radiation chemistry, and the initiation of a program in chemistry of the solid state, principally high temperature reactions and phases. Both of these fields pertain directly to large reactor projects for which the Oak Ridge National Laboratory is principally responsible. Continuation at approximately the same level is contemplated for fiscal year 1953.

	1951 actual	1952 estimate	1953 estimate
Washington area	$947,073	$1,646,053	$1,800,000

The basic chemistry program for the Washington area consists of small projects in private and public institutions which are supported in part by the Atomic Energy Commission through contracts administered by the field offices. The increases in cost for fiscal year 1953 are for full-scale operation of projects presently under contract. No provision has been made for new contracts in fiscal year 1953.

Location	Short title	1951 actual	1952 estimate	1953 estimate
Arkansas, University of	Chemical effects of nuclear transformation.	$14,000	$30,000	$40,000
California Institute of Technology.	Complex ions and reaction mechanisms in solutions.	----------	8,550	7,000
California, University of	Studies in intermolecular forces and solubility.	13,350	21,385	20,000
Canisius College	The use of iodine as a radical detector in radiation processes.	----------	11,045	7,500
Carnegie Institute of Technology	Nuclear chemistry research	32,400	40,000	42,000
Catholic University	Electrical effects at phase boundaries	2,900	10,900	8,000
Do	Rate processes in inorganic compounds at high temperatures.	2,500	10,500	8,000
Do	The thermal production and identification of free radicals.	6,237	15,000	18,000
Chicago, University of	Oxygen atom transfer reactions and purchase of mass spectrometer.	14,265	----------	----------
Do	Radiochemical and radiobiological research.	23,625	31,000	20,000
Do	Natural abundance of beuterium and other isotopes.	12,375	24,125	30,000
Do	Nuclear chemistry research	19,575	38,525	50,000
Colorado, University of	Thermochemical studies of organic fluorine compounds.	----------	18,500	15,000
Columbia University	Filtration of aerosols	7,842	28,000	10,000
Do	Separation of isotopes by chemical exchange.	18,000	20,000	25,000
Do	Basic chemical research	16,000	16,000	19,000
Do	Ion exchange chromotography	1,242	5,234	3,000
Do	Phosphate sludges	----------	30,000	30,000
Do	Photochemical reactions of iodine	----------	1,000	10,000
Connecticut, University of	Trace element distribution between a melt and solid.	5,000	10,000	12,000
Cornell University	Structure of flourocarbons, elementary boron, and boron compounds.	6,912	9,000	10,000
Emory University	Study of stability of complex ions	----------	1,000	5,000
Florida State University	Exchange between labeled halogens and certain inorganic halides.	----------	5,000	5,000
Do	Search for long-lived radioactivities	----------	1,500	10,000
Fordham University	Use of thenoyltrifluoroacetate as an analytical reagent.	4,990	10,605	15,000
George Washington University	Studies of the fluorides of the rare earth elements.	6,457	6,000	8,000
Georgia Institute of Technology	The occurrence and rate of certain deuterium exchange reactions.	2,826	6,000	7,000
Illinois, University of	Radiochemistry	8,700	15,000	15,000
Do	The mechanism of molecular motion as determined from diffusion and thermal diffusion measurements.	10,200	20,000	18,000
Illinois Institute of Technology	Studies on decomposition of organic molecules by metal photosensitization.	12,000	18,000	12,000
Do	The fundamental chemistry of ozone	5,950	14,975	12,000
Do	Studies of the properties of nonelectrolytic solutions.	9,000	21,000	12,000
Do	The acids of the hydrogen fluoride system and basic chemistry of polonium.	5,000	17,000	12,000
Do	Studies in field of stable isotopes	----------	1,500	10,000
Indiana University	Equipping of laboratory for work with radioactive tracers.	10,350	26,250	6,000
Iowa, State University of	The separation of gases by diffusion through permeable membranes.	9,775	15,000	20,000
Do	Preparation of rare earth oxides	9,000	12,000	12,000
Do	The behavior of organic compounds at the dropping mercury electrode in nonassociated anhydrous solvents.	----------	10,000	10,000
Do	The mechanisms of addition of halogen and of halogenation arising from the action of polyhalogen complexes on organic molecules.	----------	7,300	7,500
Johns Hopkins University	Studies of nuclear reactions and energy levels.	10,000	----------	----------
Kansas, University of	High temperature research	9,350	12,000	15,000
Do	Hot laboratory assistance	2,975	7,500	12,000
Do	Application of radioactive tracers to the design of distillation columns.	5,780	6,000	15,000

Location	Short title	1951 actual	1952 estimate	1953 estimate
Louisville, University of	Synthesis and properties of ion exchange resins.	$2,886	$9,000	$9,000
Massachusetts Institute of Technology.	Nuclear chemistry research	112,745	150,000	180,000
Michigan, University of	Low temperature chemical thermodynamics.	6,480	12,000	12,000
Do	Studies of water-inorganic salt-inorganic solvent systems.	3,130	----------	----------
Do	Nuclear chemical research	----------	1,500	13,000
Missouri, University of	The kinetics of the gas phase reaction between nitrogen dioxide and ammonia.	7,920	17,380	15,000
New Hampshire, University of	Inorganic fluorides	9,758	12,000	12,000
New York University	Measurement of metal dissolution rates.	14,134	12,000	12,000
North Carolina, University of	The use of flame photometer for the determination of small quantities of certain metals.	5,000	7,500	4,000
Michigan State College	A physico-chemical investigation of interhalogen compounds.	----------	25,300	40,000
North Carolina, University of	The systems: $ZrCl_4$ esters	3,466	4,400	----------
North Carolina State College	Performance of contractors for liquid-liquid extractors.	----------	28,800	31,000
Northwestern University	Investigation of the solution chemistry of ruthenium in its lower valance states.	5,625	8,000	8,000
Do	Mechanism of substitution reactions of inorganic complexes.	3,825	6,000	8,000
Do	Photochemistry of organic acids, esters, and ketones.	----------	7,000	7,000
Notre Dame, University of	Research in radiation chemistry	72,122	165,000	200,000
Oklahoma, University of	Spectroscopic properties of fluorocarbons and fluorinated hydrocarbons.	10,854	15,000	15,000
Oklahoma A. & M. College	The separation of inorganic salts by liquid-liquid extractions.	4,875	15,000	25,000
Do	(a) Anodic reactions in polarography. (b) Characteristics of a new polarographic electrode.	9,750	10,000	10,500
Oregon, University of	Construction of a mass spectrometer for use in studying chemical reaction kinetics in the gas phase.	----------	10,500	10,500
Oregon State College	A study of the mechanism of the Jacobson rearrangement.	5,000	9,000	9,000
Do	A study of generalized acid-based phenomena with radioactive tracers.	11,080	8,000	10,000
Do	Separation of deuterium from hydrogen by means of zirconium metal.	4,950	7,000	7,000
Pennsylvania, University of	Research in heterogeneous catalysis	4,000	10,000	9,000
Pennsylvania State College	Stabilities of coordination compounds and related problems.	14,752	16,000	18,000
Do	Research on the polarography of organic compounds.	12,125	15,000	14,000
Pittsburgh, University of	Synthesis of beta-diketones and beta-ketoesters with heterocyclic nuclei.	10,630	10,000	10,000
Do	Development of organic reagents for use in inorganic analysis.	8,180	10,000	10,000
Princeton University	Temporary and permanent effects produced by radiation on solids.	----------	13,200	10,000
Purdue University	A study of polarography in nonaqueous melts.	----------	8,000	6,000
Do	Metal ion chelate complexes	----------	6,000	5,000
Do	Studies in molecular spectroscopy	3,750	11,250	15,000
Do	Gas phase exchange reactions	2,250	12,000	12,000
Do	Spectrophotometric studies of complex ions.	1,750	10,000	8,000
Do	Chemistry of the polyvalent metal halides.	----------	11,500	15,000
Reed College	The atomic weight of bismuth	5,000	6,000	5,000
Rensselaer Polytechnic Institute	Fundamental investigation of the mechanism of solvent extraction of inorganic ions.	24,183	15,000	15,000
Rochester, University of	Radiochemistry	8,420	30,000	35,000
Rutgers University	Polar inorganic compounds	11,000	10,000	10,000
Do	Analytical chemistry of polyphosphates.	----------	1,000	5,000
Southern California, University of.	Solutions of inorganic electrolytes in solvents of low dielectric constant.	----------	8,000	8,000
South Carolina, University of	Study of the mechanism of allylic fluorination.	2,475	6,000	6,000

Location	Short title	1951 actual	1952 estimate	1953 estimate
Syracuse University	Mechanisms of gaseous radiation chemical reactions and the chemical reactions of electrons.	----------	$18,831	$15,000
Do	(a) Coprecipitation from homogenous solution.	----------	10,000	10,000
	(b) Analytical chemistry of thorium			
Do	Photochemical reactions of complex molecules in condensed phase.	$10,800	15,000	15,000
Tennessee, University of	Phenomena associated with radiocolloid formations.	2,100	12,700	7,400
Do	(a) The rates of catalytic reactions involving deuterium.	15,000	15,000	15,000
	(b) The relative vapor pressures of water and deuterium oxide in the presence of certain salts.			
Texas, University of	Spectrophotometric quantitative determination of the platinum metals.	7,956	10,000	10,500
Utah, University of	Ionization and dissociation of molecules by electron bombardment.	3,350	9,675	8,000
Do	Studies on surface chemistry	18,125	20,000	20,000
Do	Induction of chemical reactions by high frequency discharges in gases.	7,615	9,500	7,000
Vanderbilt University	Raman spectra of some inorganic compounds.	3,500	11,500	8,000
Do	Radiation stability and inorganic radiochemistry.	40,000	29,810	65,000
Virginia, University of	The development and study of continuously operated ion exchange separation equipment.	26,843	21,313	5,000
Washington, State College of	The formulae and stability of complex ions in solution.	2,400	12,400	8,000
Do	The experimental investigation of the stationary states of light nuclei through a search for several unknown isotopes.	2,200	12,562	8,000
Wayne University	Analytical chemistry of radioactive elements.	----------	1,000	8,000
Western Reserve University	Thermodynamic properties of gases absorbed on solids.	9,516	8,000	9,000
Wisconsin, University of	Thermoluminescence of crystals	13,100	3,700	----------
Do	Application of radioactive isotopes to chemical problems.	38,962	26,488	68,100
Do	High frequency titrations	2,700	7,000	8,000
Do	Therates and mechanisms of oxidation reactions involving cerium (IV).	4,200	9,850	8,000
Do	Chemical and physical effects of ultrasonics.	7,500	15,000	15,000
Yale University	Basic chemistry research	10,515	5,000	5,000

	1951 actual	1952 estimate	1953 estimate
Applied chemistry research	$3,619,829	$5,471,727	$6,963,000
Ames Laboratory	432,062	481,350	520,000
Argonne National Laboratory	1,255,898	1,757,961	1,825,000
Berkeley Radiation Laboratory	153,721	120,000	219,000
Brookhaven National Laboratory	314,096	377,700	525,000
Oak Ridge National Laboratory	1,418,626	1,575,913	1,374,000
Washington area	45,426	1,158,803	2,500,000

The major change in the applied chemistry program during fiscal year 1952 is the expansion in the field of geochemistry, geology, chemical processing and associated problems related to domestic raw materials sources. A cost of $1,500,000 for this work has been budgeted for fiscal year 1952 and $2,000,000 for fiscal year 1953. In the major Commission laboratories effort has been increased significantly in the field of separations process development, including both solvent extraction processes and solidification processes. The investigation of the separation of isotopes of programatic interest to the Commission has also been increased significantly. During fiscal year 1953 further expansion in the raw materials field is required, together with larger scale improvement of new separations processes.

	1951 actual	1952 estimate	1953 estimate
Ames Laboratory	$432,062	$481,350	$520,000
Scientific man-years	34.2	39.2	39.2

The applied chemistry program at Ames consists of production of pure rare-earth compounds and metals, production of stable uranium isotopes, applied research on special metals, and the analytical, spectrochemical and X-ray chemistry services associated with applied and basic research operations. Included also is chemical development of separation processes which during fiscal year 1952 includes some extraction of therium from monazite. The level of activity was increased in fiscal year 1952 by 5 man-years, which resulted largely from increased requirements of raw materials produced at Ames. The same level of technical effort is contemplated for fiscal year 1953. The increase in fiscal year 1953 costs for this activity is the result of a general increase of total costs at Ames primarily as a result of occupying the Research Building.

	1951 actual	1952 estimate	1953 estimate
Argonne National Laboratory	$1,255,898	$1,757,961	$1,825,000
Scientific man-years	32.3	49.8	44.0

The applied chemistry program at the Argonne National Laboratory includes study of fission yield of uranium, capture cross sections of uranium isotopes, production of certain transuranic elements, separation studies and physical properties of reactor materials, determination of low level contamination in the atmosphere, and the development of separation processes. Increased effort during fiscal year 1952 is the result of an increased development work on the volatility process and engineering feasibility studies. During fiscal year 1953 the applied chemistry program will be continued at approximately that of fiscal year 1952.

	1951 actual	1952 estimate	1953 estimate
Berkeley Radiation Laboratory	$153,721	$120,000	$219,000
Scientific man-years	6.0	7.0	12.0

Please refer to the classified justification material for information in regard to this estimate which appears on page 324.

	1951 actual	1952 estimate	1953 estimate
Brookhaven National Laboratory	$314,096	$377,700	$525,000
Scientific man-years	7.9	15.0	21.2

The applied chemistry program at Brookhaven includes long-range studies of fuel processing and breeders, heavy water separation and uranium processing by extractive distillation, which is part of the Argonne development work in this field. Expansion of the effort is planned both in fiscal year 1952 and fiscal year 1953 in order to carry successful methods through semiworks and pilot plant stages of operation.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$1,418,626	$1,575,913	$1,374,000
Scientific man-years	49.3	57.4	60.5

Please refer to the classified justification material for information in regard to this estimate which appears on page 324.

	1951 actual	1952 estimate	1953 estimate
Washington area	$45,426	$1,158,803	$2,500,000

The applied chemistry program of the Washington area consists of work in the field of raw materials, both on-site and off-site, and miscellaneous applied chemistry projects to be carried out in public and private institutions. The major portion of the $1.2 millions estimated for fiscal year 1952 costs has been included for an expanded program in geochemistry, geology, chemical processing, and related investigations which are appropriate for the development of fundamental information on domestic raw materials supplies. During fiscal year 1953, the total raw-materials program is expected to reach a level of approximately $2.0 millions and the off-site applied chemistry activities about $0.4 millions. Following is a list of institutions assigned research under this program:

Location	Short title	1951 actual	1952 estimate	1953 estimate
Arkansas, University of	Investigation of the radioactivity of thermal waters and its relationship to the geology and geochemistry of uranium.	----------	$45,000	$65,000
California Institute of Technology.	Geochemistry of uranium	----------	182,610	200,000
Columbia University	U-PB method of age determination	----------	20,500	25,000
H. K. Ferguson Co	Heavy water survey	----------	4,000	30,000
Florida, University of	Preparation and properties of quaternary ion exchange resins.	----------	8,735	10,000
Hydrocarbon Research, Inc	Survey of chemical and engineering problems related initially to chemical processing matters.	$8,521	----------	----------
Illinois Institute of Technology	The fundamental chemistry of uranium.	----------	9,000	14,000
Do	Studies in chemistry of ruthenium	9,620	17,135	----------
Interior, Geological Survey	Fundamental research on geology and geochemistry of uranium.	----------	263,500	300,000
Massachusetts Institute of Technology.	Techniques in mineral engineering	----------	80,000	80,000
Ralph M. Parsons Co	Study of the separation of deuterium and hydrogen by fractional absorption.	4,500	----------	----------
Pennsylvania State College	An investigation of the mineralogy and petrography of U-bearing shales.	----------	40,000	45,000
Princeton University	Research in analytic chemistry	----------	20,000	20,000
Do	Study of nucleation processes	----------	43,910	50,000
Washington University	The separation of lithium isotopes	----------	24,645	10,000
Wayne University	Solubility of uranium and thorium oxides in dilute acid base.	----------	7,800	10,000
Wisconsin, University of	New methods for uranium exploration and recovery from low-grade ores.	----------	125,000	100,000
National Bureau of Standards		----------	75,000	155,000
New Hampshire, University of	Infrared spectroscopy of inorganic fluorides.	----------	10,700	11,000
Tennessee, University of	Investigation of Chattanooga shales	22,785	25,000	25,000
New contracts to be assigned in fiscal year 1952 (raw materials).		----------	156,268	148,200
Projects to be named fiscal year 1953 (for new off-site contracts and for assignment of new projects to Commissioned-owned installations in the fields of raw material research and new chemical methods for separation of isotopes of interest to the Commission).		----------	----------	1,201,800

Metallurgy and materials research category

Activity	1951 actual	1952 estimate	1953 estimate
Basic metallurgy and materials research	$1,760,242	$2,170,947	$2,635,000
Applied metallurgy and materials research	1,317,872	2,309,171	2,989,000
Total accrued costs	3,078,114	4,480,118	5,624,000

The metallurgy and materials category includes basic and applied work on metals, alloys, ceramics, and other materials of special interest in AEC operations. Research in this field (1) provides an accumulation of fundamental data for development of materials as may be required in the future, (2) applies the results of research to the materials needs of the Commission, and (3) produces tests quantities of special new materials as required. It consists of programs carried out in the Commission-operated laboratories, in universities, and by industry.

The growth of the metallurgy and materials programs at the Commission-operated laboratories were retarded during fiscal year 1951, by the diversion of personnel to pressing problems in reactor development and production. During fiscal year 1952 an increase of 45 percent is being made at the Commission-operated laboratories with a smaller increase in fiscal year 1953. In general, fields in which effort is being increased in fiscal year 1952 and fiscal year 1953 include thorium, as a breeder material; ceramic materials; liquid metals, which are of interest in high temperature reactors; graphite and zirconium; and the general field of radiation damage to reactor materials.

	1951 actual	1952 estimate	1953 estimate
Basic metallurgy and materials research	$1,760,242	$2,170,947	$2,635,000
Ames Laboratory	168,141	183,630	200,000
Argonne National Laboratory	537,836	714,328	800,000
New York area	60,443	83,000	85,000
Oak Ridge National Laboratory	232,873	390,000	650,000
Washington area	760,949	799,989	900,000

The basic metallurgy and materials research carried on by the Commission provides fundamental information on the source and fissionable materials; reactor materials, including ceramics; and various metals and alloys of interest in Commission operation. During fiscal year 1951 a considerable amount of effort was diverted from basic studies to urgent reactor and production programs. Increases in cost in fiscal year 1952 and fiscal year 1953 reflect a rebuilding of the basic research program, particularly at the Argonne and Oak Ridge National Laboratories.

	1951 actual	1952 estimate	1953 estimate
Ames Laboratory	$168,141	$183,630	$200,000
Scientific man-years	9	10	10

The basic metallurgy research in the Ames Laboratory is concerned with thorium, uranium, and zirconium, the rare earths, and alloys of these and other metals. The results of the basic research provide an accumulation of data which serves as a basis for applied work at Ames and elsewhere.

During fiscal year 1952 the level of effort has increased by 1 man-year above the fiscal year 1951 level and will be held at that level during fiscal year 1953. The estimated increase in costs for this activity in fiscal year 1953 is the result of a general increase of total costs at Ames primarily as a result of occupancy of the Research Building.

	1951 actual	1952 estimate	1953 estimate
Argonne National Laboratory	$537,836	$714,328	$800,000
Scientific man-years	13.6	16	15

The basic metallurgy and materials research at the Argonne National Laboratory includes studies of phase changes, phase diagrams, grain structures, growth and diffusion, and mechanical properties of pure metals at high temperatures. It also includes studies of the refractory compounds of uranium and thorium, which may be useful in high-temperature reactors.

During fiscal year 1952 the level of the program has been increased by approximately 2 man-years. During fiscal year 1953 a decrease of 1 man-year is estimated because of expected limited availability of manpower. The cost increase of approximately 15 percent during fiscal year 1953 is due in part to the expensive health precautions which are necessary in metallurgical work involving plutonium and in part to increased usage and higher allocation of costs of operating reactors at the Argonne National Laboratory.

	1951 actual	1952 estimate	1953 estimate
New York area	$60,443	$83,000	$85,000
Scientific man-years	4	4	4

The basic metallurgy and materials research at the Massachusetts Institute of Technology consists of fundamental studies on uranium, thorium, beryllium, and aluminum, with particular emphasis on forming methods.

The program is being held at its fiscal year 1951 level of effort in fiscal year 1952 and fiscal year 1953 with increased costs in fiscal year 1952 due largely to the general wage and price increases. The higher costs during fiscal year 1952 and fiscal year 1953 also include supplies and some additional equipment which is treated as an expense item.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$232,873	$390,000	$650,000
Scientific man-years	6.7	13.0	23.0

The basic metallurgy and materials research at the Oak Ridge National Laboratory concerns work on thorium, titanium, zirconium, hafnium, and uranium and their alloys. The studies are concerned primarily with effects of fabrication conditions, and radiation effects. The program includes basic studies of ceramics materials.

During fiscal year 1951 the level of effort in basic metallurgy and materials research at the Oak Ridge National Laboratory was significantly decreased by the transfer of technical personnel to reactor projects. During fiscal year 1952 and fiscal year 1953 basic research is being rebuilt and slightly expanded to include ceramics studies along the lines of the program formerly carried on at the NEPA project in Oak Ridge.

	1951 actual	1952 estimate	1953 estimate
Washington area	$700,949	$799,989	$900,000

The basic metallurgy and materials research in the Washington area consists of projects carried out in public and private institutions and commercial laboratories through contracts administered by the AEC operations offices. The program on basic research remains at an approximately constant level during fiscal year 1952 as compared with fiscal year 1951. The fiscal year 1953 costs include an increase of $100,000 which is recommended as the minimum which is appropriate in view of the Commission's expanded program and is thought to be compatible with the limited availability of scientific personnel and physical facilities available. Following is a listing of institutions carrying out these investigations:

Location	Short title	1951 actual	1952 estimate	1953 estimate
Alabama, University of	Research investigations of enamels for metals.	$5,400	$6,000	$6,000
Arkansas, University of	Recrystallization of aluminum oxide	----------	8,640	10,000
Bausch & Lomb Optical Co	Irradiation damage to glass	----------	15,000	15,000
California, University of	Creep of alloys	73,794	62,100	60,000
Do	Mechanics of metal ceramic bonding	----------	10,000	10,000
Carnegie Institute of Technology	(a) Studies of grain boundaries and lattice imperfections; (b) thermodynamic properties of binnary alloy systems; (c) corrosion of metals and alloys.	61,000	60,000	61,000
Do	Electrochemical studies of nonaqueous melts.	23,868	24,000	24,000
Carnegie Institute of Technology (ONR)	Low temperature specific heat measurements.	3,000	----------	----------
Columbia University	The study of diffusionless phase changes in solid metals and alloys.	26,838	44,390	29,600
Do	(a) The fundamental mechanism of metallographic etching; (b) electrolytic cutting of metals.	18,338	12,000	12,000
Do	Heat transfer by natural convection to liquid metals.	2,970	2,989	----------
Dow Chemical Co	The effect of nonmetallic and alkali metal impurities on the corrosion rate and corrosion characteristics of magnesium.	41,200	36,000	30,000
Dow Chemical Co. (ONR)	Fundamentals of magnesium alloying	5,174	5,000	5,000
Illinois, University of	Mechanism of substitutional diffusion in metals.	27,772	26,736	21,400
Do	Annealing of cold-worked metals	----------	21,056	22,000
Illinois Institute of Technology	Imperfections in solids	----------	6,000	6,000
Iowa, State University of	The structure of intermetallic compounds.	12,000	10,000	10,000
General Electric	Fundamental metallurgical research	150,000	150,000	150,000
MIT	(a) Thermodynamics of metal solutions; (b) solid solutions in grain boundaries; (c) fundamentals of cold working and recrystallizations.	107,032	90,000	90,000
Do	Mechanical properties of metals at low temperatures.	----------	29,620	30,000
Minnesota, University of	Effect of chemical nature of surfaces on heat transfer in boiling liquids.	----------	8,200	10,000
North Carolina	Measurements of thermal properties of nonmetallic materials at high temperatures.	----------	33,000	33,000
Pennsylvania, University of	Thermodynamic study of the iron-oxygen-sulfur system.	4,000	8,300	----------
Pittsburgh, University of	Thermochemistry of alloys	26,404	27,000	27,000
Rensselaer	Anisotropic self-diffusion in metals	6,395	6,500	6,500
Syvania Electric Products Co	Self-diffusion and high-temperature phenomena.	143,964	64,958	80,000
Tennessee, University of	Energy changes from plastic deformation.	11,200	11,500	11,500
Do	Wetting by liquid metals	10,500	21,000	21,000
Projects to be named (for research in heat transfer, research in materials such as graphite, beryllium, and zirconium).		----------	----------	129,000

	1951 actual	1952 estimate	1953 estimate
Applied metallurgy and materials research	$1,317,872	$2,309,171	$2,989,000
Ames Laboratory	347,196	386,030	425,000
Argonne National Laboratory	----------	109,380	360,000
Brookhaven National Laboratory	177,369	320,600	440,000
Chicago area	208,603	203,000	203,000
New York area	188,510	243,500	211,000
Oak Ridge National Laboratory	115,333	187,000	200,000
Washington area	280,861	859,661	1,150,000

The applied metallurgy and materials research program provides for (1) the development of new materials potentially useful in reactor operation, (2) programmatic work on materials now in use, and (3) the production of small quantities of special materials for test purposes. Major changes in the programs in this field have occurred at the Argonne and Brookhaven National Laboratories and in the off-site program in the Washington area. These changes are discussed in detail below.

	1951 actual	1952 estimate	1953 estimate
Ames Laboratory	$347,196	$386,030	$425,000
Scientific man-years	20	21	21

The applied metallurgy program at the Ames Laboratory includes (1) development of methods for producing pure salts and metals and production costs for special materials as required throughout the Commission, (2) physical and chemical studies of the properties of these materials which are of particular interest to the Commission, and (3) studies of the properties and preparation of high temperature ceramics for reactor use and for general metallurgical purposes.

During fiscal year 1952 an increase of one scientific man-year is the result of the large thorium program under way. It is anticipated that work will continue at the same level during fiscal year 1953. The estimated increase in costs for this activity in fiscal year 1953 is the result of a general increase of total costs at Ames primarily as a result of occupancy of the Research Building.

	1951 actual	1952 estimate	1953 estimate
Argonne National Laboratory		$109,380	$360,000
Scientific man-years		3.0	8.0

The applied metallurgy and materials research at the Argonne National Laboratory is concerned with uranium fabrication and uranium alloy development. This applied work was initiated in fiscal year 1952 and it is expected that during fiscal year 1953 the activity will be broadened to include plutonium metallurgical problems and the irradiation effects on metals.

	1951 actual	1952 estimate	1953 estimate
Brookhaven National Laboratory	$177,369	$320,600	$440,000
Scientific man-years	4.0	10.6	14.5

The applied metallurgy and materials research at the Brookhaven National Laboratory is concerned primarily with the effects of radiation on structural materials and with the development of liquid fuel elements. During fiscal year 1952 the program is being materially increased to make use of the Brookhaven reactor and other new facilities. A further increase during fiscal year 1953 is contemplated to provide additional information related to reactor development problems.

	1951 actual	1952 estimate	1953 estimate
Chicago area	$206,603	$203,000	$203,000
Scientific man-years	10	10	10

The applied metallurgy and materials research at the Battelle Memorial Institute includes studies of fabrication of graphite for increased resistance to radiation damage, uranium metallurgy, and the development of new ceramic materials for service in high temperature reactors. The program will remain at a substantially constant level during fiscal year 1952 and fiscal year 1953.

	1951 actual	1952 estimate	1953 estimate
New York area	$188,510	$243,500	$211,000
Scientific man-years	12	13	12

This project, which is carried out by Massachusetts Institute of Technology, includes radiation damage studies, uranium and thorium metallurgy, ceramics

development and studies of zirconium, aluminum, and other metals for reactor use. An increase of one man-year during fiscal year 1952 represents a temporary increase in radiation damage work. During fiscal year 1953 the program will be continued at about the fiscal year 1951 level.

	1951 actual	1952 estimate	1953 estimate
Oak Ridge National Laboratory	$115,333	$187,000	$200,000
Scientific man-years	3.6	3.5	4.5

The applied metallurgy and materials research at the Oak Ridge National Laboratory includes research in the ceramic materials, fabrication of crucible tubes for special requirements, and creep studies on uranium. In general, the work is channeled in directions most appropriate to the needs of reactor technology activities. An increase of one man-year in fiscal year 1953 in the ceramics field is contemplated. During fiscal year 1952 a program of in-pile creep testing was begun which accounts for the major portion of the cost increase during that year.

	1951 actual	1952 estimate	1953 estimate
Washington area	$280,861	$859,661	$1,150,000

The applied metallurgy and materials in the Washington area consists of projects carried on in public and private institutions and commercial laboratories in support of major program activities of the Commission-operated laboratories. It includes metallurgical work related to the production and reactor development programs. The large increase in costs during fiscal year 1952 and fiscal year 1953 results in part from the increase in tempo of activity in these fields. In addition, an expanded effort in the field of radiation damage began in fiscal year 1952. An appreciable expansion in the field of liquid metals occurred in fiscal year 1952 and will continue in fiscal year 1953. Following is a listing of institutions carrying out these investigations:

Location	Short title	1951 actual	1952 estimate	1953 estimate
Alfred University (ONR)	Development of method to measure high temperature thermal conductivity of nonmetallic materials.	$10,000	$10,000	----------
American Smelting & Refining Co.	Research on liquid metals	16,359	----------	----------
California, University of	Scope I: Metallurgical investigation of materials subjected to liquid lead-bismuth environments—scope II: Heat transfer characteristics of liquid lead-bismuth.	----------	55,000	----------
Carnegie Institute of Technology	Radiation effects	----------	20,000	$20,000
Chicago, University of	Research on the structure and properties of graphite.	7,500	13,786	----------
Columbia University (Kehl)	Uranium, molybdenum alloys	858	4,714	----------
Columbia University	Boiling and condensing of liquid metals.	----------	13,500	13,500
Do	Mass transfer studies	----------	17,500	17,500
Do	Thermodynamic properties of sodium vapor.	----------	11,600	11,600
Columbia University	Electrolytic production of zirconium metal.	----------	35,000	35,000
Dow Chemical Co	The room and elevated temperature properties of magnesium-base alloys containing 1 or more of the elements Al, Be, and Zr.	11,300	11,310	----------
Graham, Crowley Association	Means for the electrodeposition of zirconium.	----------	23,600	23,600
Great Lakes	Graphite purification studies	----------	18,500	----------
Horizon's Inc	Processes for preparation of zirconium metal.	----------	25,000	25,000
Illinois, University of	Experimental and theoretical investigation of radiation damage in solid materials.	----------	115,000	130,000
General Electric	Zirconium alloys	34,888	75,000	75,000

Location	Short title	1951 actual	1952 estimate	1953 estimate
Massachusetts Institute of Technology.	Refractories research	$32,544	$40,000	$48,362
Do	Research on nature of distortion on radiation damaged materials.	17,234	20,000	20,000
Do	Ceramic-metal wetting and sintering		24,000	24,000
National Bureau of Standards	Applied research studies	107,600	197,961	147,624
Ohio State University	Electron energy bands of He, Zr, Ti, Mo alloys.		12,000	12,000
Pennsylvania State College	The corrosion of zirconium	2,608	26,000	26,000
Purdue University	Effect of cyclotron radiation on metals and alloys.	12,750	60,000	60,000
Sintercast Corp	Sintered zirconium carbide	18,020		
Stanford University	Resistance of materials to environments of molten lead and bismuth.		10,190	
Wichita, University of	The permeability method of determining surface areas of finely divided materials.	9,200	20,000	20,000
Projects to be named for new methods for (1) production of zirconium, (2) development of ultra-high purity beryllium, (3) development of high density graphite, (4) research on processes for production of uranium, (5) research on fabrication techniques for Be_2C and other materials as the problems arise.				440,814

Mathematics and computations research category

Activity	1951 actual	1952 estimate	1953 estimate
Basic mathematics and computations research	$140,795	$149,000	$100,000
Total accrued costs	140,795	149,000	100,000

A vigorous program in basic mathematics and computations is necessary in all phases of research and development. Varied and extensive computations, often utilizing high speed computers, are requirements in the design of nuclear weapons and reactors and for the application of mathematical techniques to problems of physics and the theoretical interpretation of the results of experiments in nuclear physics. It is therefore necessary to extend our knowledge of mathematics in such fields as the theory of groups, matrix algebra, and the theory of nonlinear differential equations. This research is carried on through the following research contracts:

Location	Short title	1951 actual	1952 estimate	1953 estimate
Institute of Advanced Study	Development of high speed computing devices and extension of existing computer building at the institute.	$126,000	$132,666	$83,500
Tennessee (ONR)	Algebraic applications of canonical matrices.	8,545	11,000	11,000
Kenyon College	Mathematical studies in Boolean theory and Hilbert space.	6,250	5,334	5,500

University training and cooperation category

Activity	1951 actual	1952 estimate	1953 estimate
Fellowship program in the physical sciences	$562,341	$739,000	$500,000
Other training in the physical sciences	398,715	485,000	504,000
Total accrued costs	961,056	1,224,000	1,004,000
Fellowship program in the physical sciences:			
Argonne National Laboratory	154,852		
Berkeley Radiation Laboratory	47,724		
New York area	72,087		
Oak Ridge area	27,488	639,000	482,000
Washington area	260,190	100,000	18,000
Total	562,341	739,000	500,000

The fellowship program was originally established to assure a continuing source of highly trained scientific personnel in those fields of the physical sciences relating to the use and development of atomic energy. During fiscal year 1952 the fellowship program is being administered principally by the Oak Ridge Institute of Nuclear Studies.

It is planned that the Commission's fellowship program will be limited during fiscal year 1953 to the renewal of existing fellowships. No new awards are contemplated by the Commission. The amount shown for fiscal year 1953 costs include costs of $210,000 to cover termination of the appointments made in fiscal year 1952. The remaining $290,000 contained in the estimate covers costs of the renewal appointments made for the academic year commencing September 1952. The following shows the actual and estimated number of fellows participating in the program, with the corresponding fellow-years and costs:

	1951 actual			1952 estimate			1953 estimate		
	Active fellows	Fellow-years	Amount	Active fellows	Fellow-years	Amount	Active fellows	Fellow-years	Amount
Predoctoral	255	208	$538,743	300	253	$648,000	300	170	$444,000
Postdoctoral	25	7	23,598	32	27	91,000	32	16	56,000
Total	280	215	562,341	332	280	739,000	332	186	500,000

	1951 actual	1952 estimate	1953 estimate
Other training in the physical sciences: Oak Ridge area	$398,715	$485,000	$504,000

The work conducted under this activity is carried on by the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies.

At the Oak Ridge National Laboratory, the program is for the purpose of bringing university staff members into the laboratory for limited periods to acquaint them with the techniques and practical knowledge which are unique with the atomic energy installations, and to obtain simultaneously the benefit of their research and engineering experience in the Commission's program. University representatives normally spend 3 months at the laboratory, although in some cases appointments extend for 1 year. Fifty-five faculty members from 31 universities participated in the program during fiscal year 1951, and the program will continue at approximately the same level during fiscal year 1952 and fiscal year 1953.

The estimates for the Oak Ridge Institute of Nuclear Studies contemplate continuation of (1) the resident graduate program under which the Commission provides facilities and equipment for graduate courses in chemistry, physics, mathematics, and biology for employees of the Commission and its contractors at Oak Ridge—the University of Tennessee provides a staff and faculty on a nonreimbursable basis; (2) the Oak Ridge graduate program which provides fellowships whereby universities may supplement their own research facilities by assign-

ing their Ph. D. candidates to the Oak Ridge National Laboratory to utilize unique facilities for thesis research; (3) the research participation program, which provides the means for arranging interchange of staff from southern universities to the Oak Ridge research groups; (4) the special training, which includes the radioisotope techniques courses and advanced courses in the use of unusual research techniques which have been developed largely in Commission laboratories; and (5) the American Museum of Atomic Energy, which serves to disseminate general atomic energy information in the field of public education.

The cost increase of $19,000 projected for fiscal year 1953 results largely from the increase in fellowship activities under the Oak Ridge graduate program which are projected to increase from 21.5 man-years in fiscal year 1952 to 27.5 man-years in fiscal year 1953.

Following is a breakdown of the fiscal year 1953 program under this budget estimate for the Oak Ridge Institute of Nuclear Studies:

	Total	ORINS contribution	AEC contribution
1. Resident graduate program	$43,000	$16,000	$27,000
2. Oak Ridge graduate program	56,000	5,000	51,000
3. Research participation program	54,300	4,000	50,300
4. Special training division	61,100	1,400	59,700
5. American Museum of Atomic Energy	48,800	1,800	47,000
6. Miscellaneous activities	40,000	1,000	39,000

The university training and cooperation activities at the Argonne National Laboratory are not carried as a budgetary item as in the case of ORNL. Under the present arrangement, positions are maintained in the scientific divisions for university participants, and the cost of their participation is included under physics, chemistry, or metallurgy.

Additional information of a classified nature for the physical research program is presented in the following pages 323–330.

Detailed Justification of Construction

Physical research construction sub program

	1951 actual	1952 estimate	1953 estimate
Cost obligated	$5,341,568	$4,894,115	$5,985,000
Cost incurred	16,140,640	15,600,000	7,200,000

DETAIL JUSTIFICATION OF COSTS TO BE OBLIGATED IN FISCAL YEAR 1953 FOR CONSTRUCTION

Project No. 5–422–9004—Alterations and improvements, Ames, $35,000

The specific jobs to be done in fiscal year 1953 cannot be detailed; however, based upon experience it is known that changes and improvements in research facilities, to meet special needs of current research activities, will be required. Similar requirements during fiscal year 1951 and fiscal year 1952 totaled $78,500 and $15,000. The heavier requirements in fiscal year 1951 resulted from the moves to the new metallurgy and research buildings.

Project No. 5–424–1001—Chemistry laboratory, Berkeley, $500,000

This project consists of a laboratory-type building required to provide suitable space for the chemistry-research program. By building this structure the presently scattered and crowded chemistry groups would be relocated in a way that would enhance productivity and safety.

In the past year it has become apparent that a minimum of 46,000 square feet instead of the previously estimated 30,000 square feet will be required to house the personnel and large scientific instruments engaged in the chemistry work of the laboratory. In addition, construction costs in the immediate area have increased as much as 18 to 20 percent higher than those of July 1950. In order to accomplish the purpose of this project the sum of $500,000 is required over and above the $45,000 and $805,000 provided for this item in fiscal year 1951 and fiscal year 1952.

Project No. 5–424–2002—Electronics research building, Berkeley, $225,000

Since the destruction by fire of the building that previously housed the electronics and physics groups associated with the 184-inch cyclotron and the linear accelerator, the work has been crowded into two small buildings, adding to their fire hazards and preventing certain experiments from being carried out. This project, a three-level fireproof building of approximately 15,000 square feet, will provide the badly needed space and will be located in an area adjacent to the accelerators for ease in the moving of very large, delicate equipment. It is proposed to begin the design work in fiscal year 1952 for which $25,000 is being expended. Actual construction, estimated to cost $225,000, will start as soon as possible after funds are appropriated in fiscal year 1953.

Project No. 5–424–3001—Miscellaneous construction, Berkeley, $250,000

This project consists of miscellaneous construction items each under $100,000, in total cost, which may be grouped as follows:

1. Advance plans	$5,000
2. Fire protection	45,000
3. Laboratory alterations	45,000
4. Major accelerator improvements	20,000
5. Minor building alterations and construction	30,000
6. Roads and parking	20,000
7. Small construction, other improvements, and utility extension	85,000
Total	250,000

Justification for the various parts of this project follow:

(*a*) Advanced plans. A small fund is required to make preliminary engineering and design studies prior to establishing definite projects. In addition, a certain amount for long-term studies, which never are a part of any one project is required.

(*b*) Fire protection. Under a systematic program of providing adequate fire protection for the laboratory, provision is made in fiscal year 1953 for additional storage and high-pressure water lines and miscellaneous smaller improvements.

(*c*) Laboratory alterations. Due to changes of emphasis, changes of techniques, and changes of personnel, there is a constant demand for alterations to laboratories. These alterations are a very necessary part of a progressive research program.

(*d*) Major accelerator improvements. Because of the research nature of accelerators, it is necessary to periodically make modifications and improvements. Major changes of this nature are charged to plant and equipment.

(*e*) Minor building alterations and construction. These funds are required to alter present buildings and to construct small buildings not large enough to be considered independently. Usually these changes are required by the changing research program or operating requirements. The exact nature is hard to predict but past experience indicates a constant volume of these changes.

(*f*) Roads and parking. Construction of new buildings and projects in practically all cases requires relocation of additional roads and parking areas. Also heavy traffic makes necessary periodic replacement of pavement. Steep slopes at the laboratory cause a scarcity of level ground for building sites and exaggerate the road and parking situation.

(*g*) *Small construction, other improvements and utility extension.* Under this item, small miscellaneous jobs necessary for everyday operation, utility extensions to new areas and other improvements are budgeted. Revisions to the utility systems to provide for the various research requirements are included. Also included are amounts for security requirements and land improvements.

Cost estimates for these items are based primarily on past experience and the expected workload. For laboratory alterations, it is impossible to predict in advance the exact nature but the extent of such alterations in total can be fairly accurately predicted.

Project No. 5–222–0001.—Reactor additions and adjustments, Brookhaven, $50,000

Continuing additions, modifications and adjustments to the Reactor over and above ordinary maintenance, repairs and operating adjustments, are required to permit efficient use of the instrument. Specific requirements for fiscal year 1953 cannot be detailed; however, it is known that some modifications will be necessary. Requirements in fiscal year 1952 are estimated at $50,000 and a like amount is estimated for fiscal year 1953.

Project No. 5–222–2007.—Cyclotron additions and adjustments, Brookhaven, $25,000

Efficient use of a research instrument such as the cyclotron requires constant and continuing modifications, improvements, and adjustments dictated by the self-developing changes in the nature of the projects using the cyclotron. Specific requirements cannot be detailed inasmuch as the needs for the changes, improvements, and additions are to a large extent the result of the development of the research program.

Project No. 5–241–3008—Addition to physics of solids building, ORNL, $700,000

This building, a two-story structural steel frame, with reinforced concrete and brick structure, approximately 10,000 square feet of floor space, is structurally and architecturally similar to and will be attached to the existing physics of solids laboratory. It is required, due to the immediate need of an accelerated program for the development of materials proposed for use in the construction of prototype reactors. These many current problems necessitate additional facilities to house more personnel and equipment to carry out the objectives of the expanded program. Such additional requirements were not anticipated at the time the design criteria for the present building were being developed. The estimated cost for this facility has not been determined by comparison of costs of the construction of similar installations.

Project No. 5–241–1026—Research reactor, ORNL, $2,700,000

This project covers the design and construction of a nuclear reactor, including a building with services and equipment necessary to operate the reactor. Experimental reactor facilities with a higher flux are needed at ORNL in order to carry out the approved programs in irradiation effects of solids and liquids, which is part of the reactor development and the fundamental physics, chemistry, and metallurgy programs. This requirement cannot be met by the existing Oak Ridge graphite reactor which was designed as a prototype plutonium producer. As such, its structure and low intensity flux restrict the value as an experimental tool for observing the irradiation effects of solids and liquids. A low neutron flux impedes the observation of irradiation damage phenomena and the existing graphite reactor lacks the space necessary for the many tests that must be made. The new reactor would be used for those purposes for which the current reactor is inadequate, or in cases where adequate space cannot be obtained in the graphite reactor. The sum of $100,000 was authorized in fiscal year 1951 for preliminary design; through this study and on experience developed for the MTR, the estimates for this construction are based.

Project No. 5–241–3031—Relocation of ORINS facilities, $185,000

The eight specific programs of the ORINS are presently located in all or part of eight separate temporary or semipermanent buildings, which are spaced at several widely separated points as much as 6 to 8 miles apart in some cases. The current programs have all facilities overoccupied with no room to house any increase. A review of the anticipated program and present building facilities indicates an immediate need for a permanent, centrally located structure to house the programs of the institute. The Glenwood School at Oak Ridge meets this requirement and has been released from community operations as surplus. Beneficial occupancy of this building would obviate the need to sell it for salvage or place it in standby. The building generally is in good condition and should last 10 to 15 years without any major capital improvement.

Project No. 5–241–3043—Hot waste collection tanks, ORNL, $243,000

This project provides for the construction of additional hot waste tanks. The tanks will be constructed in the ORNL hot waste farm. The project also provides for the necessary hot waste tie-ins to the existing system and the required jet handling equipment to move the liquid wastes from the tanks to the liquid waste decontamination system. Two factors lead to the need for additional tanks within the next year; the first being the increased capacity required of the waste storage system due to an increased volume of uranium metal and radiochemical wastes. The second factor is the evidenced deterioration of the existing tanks which were constructed in 1943 to serve the plutonium pilot plant and were designed to have a life of approximately 3 years. Storage capacity for uranium and radiochemical wastes at ORNL would become very critical if one or more of the present tanks were lost from service due to deterioration and possible reduction in chemical processing activity would result.

Project No. 5–241–3050—Iodine 131 and cesium 137 processing facilities, ORNL, $200,000

This project provides for (1) the construction of a six-cell processing plant and processing and handling equipment required for the production of iodine 131 and (2) for equipment and modifications to existing buildings to provide the required facilities for large-scale cesium 137 production.

Iodine 131 is the largest-selling isotope under the Commission's radioisotope program, and enjoys a large demand in industrial and medical research, clinical diagnosis, and the treatment of thyroid disorders. The isotope has a half-life of only 8 days and therefore must be in constant production to meet requirements.

The present plant has been in daily use for 5 years and is currently being run at three times the designed capacity, with no stand-by facilities. As a result, increasingly frequent shut-downs for repair of equipment vital to the process have occurred. Shut-downs have materially delayed production, resulting periodically in large backlogs of orders. This condition will become more serious as increasing shut-downs occur and the demand increases.

The proposed plant will make possible reduced operating and maintenance costs based on improved design and the provision of duplicate processing equipment in separate cells. The latter allows for easier decontamination and repair while the plant is in operation.

Cesium 137 is available from fission product wastes resulting from various ORNL chemical processings. It gives off gamma radiation which is softer than that from cobalt 60 and is being considered as a source for teletherapy units because of its more economical production and greater absorption of gamma radiation per gram of tissue than in the case of cobalt 60. The product produced as a result of this project would be sold under the radioisotope program in the form of multicurie sources for medical research and other uses.

Project No. 5–241–2003—General plant projects, Oak Ridge National Laboratory, $722,000

In order to maintain adequate facilities to serve the 3,700 employees, continued and various alterations and modifications to buildings and equipment are necessary. Experience of past years has proved it difficult to anticipate with accuracy at the time the budget is prepared, funds necessary to finance the types of work which often unexpectedly arise. The estimate for fiscal year 1953 shown here is based on the cost experience of past years.

Project No. 5–500–3001—Accelerator, location undetermined, $150,000

This accelerator will be installed at a university to implement the program of the Commission of supporting fundamental research in the nuclear sciences. No funds are provided for structures required to house the machine inasmuch as these facilities are generally constructed or furnished by the university. The $150,000 figure is based upon the cost of the latest accelerator provided Brookhaven.

FUNCTIONS

Dr. JOHNSON. I have a general statement which I can place in the record.

Senator MAYBANK. Does all research come under your supervision?

Dr. JOHNSON. Our program covers mainly basic research in the physical sciences. We get a little into the development side.

Senator MAYBANK. But the main development is with the other divisions and the other branches.

Dr. JOHNSON. They take up where we leave off.

Mr. BOYER. This is exclusive of weapons research.

Senator MAYBANK. This has nothing to do with weapons.

Mr. BOYER. That is correct.

Dr. JOHNSON. That is by and large the fact. Some of the things that we get into have to do with weapons.

Senator MAYBANK. The research on weapons, that would be separate from this. This research would go into civilian use; would that be right?

Dr. JOHNSON. This research is largely geared toward a better understanding of the whole basic phenomena, and it is not aimed so much at technical uses. We are trying here to take some of the cut-and-dried out of this business—to get a better understanding so that things can be calculated in advance in good engineering fashion.

Senator MAYBANK. Thank you.

OPERATIONS PROGRAM

Dr. JOHNSON. We are requesting an appropriation of $43.1 million for the operating program, which is about a 16-percent increase over last year.

Senator MAYBANK. Why is that? Are you doing more research work or are the plants enlarging so that it is necessary?

Dr. JOHNSON. There are a number of factors here.

Senator MAYBANK. If you have it in your statement, will you go ahead with that.

Dr. JOHNSON. I might state again the area which this research covers. It is for acquisition of basic knowledge in the fields of physics, chemistry, metallurgy, and geology. All of these things are foreseeably related to the atomic energy program, of course. Then there is a certain amount of research which is undertaken in acquisition of specific knowledge having immediate application in the design of weapons, reactors, the production of fissionable material, and the procurement and processing of raw materials. A large part of the basic research program supported by the Commission is integrated with the teaching and training activities of the universities and its chief function is to intensify and orient the research of many of the country's best-qualified scientists and their students in those directions calculated to be most fruitful in discoveries which will enable the United States to keep the initiative in the atomic race. We cannot hope to hold our present position of leadership on the basis of knowledge we already possess, and our strength relative to other nations in 5 or 10 years from now will depend in large measure upon the basic research now going on in our own laboratories and in those of our adversaries. I refer here to the type of research activity which 10 or 12 years ago resulted in the discovery of plutonium and the fission of uranium, and which in our own program has resulted in recent discoveries of comparable importance.

On the programmatic side in a number of instances we are intensifying the development of applications of recent discoveries so that they can be integrated into the weapons or production programs in the shortest possible time, and in other instances we are getting specific data and are developing specific materials required to complete the designs of devices and processes which are already well along. We are also expanding research on methods of procuring and processing uranium ores.

UNIVERSITIES AND INSTITUTIONS

Our research activities are divided between the universities and institutions on the one hand and the Commission-operated national laboratories on the other.

Of the $43.1 million requested, $15 million—an increase of $3.6 million over last year—will be used to finance work in universities

and institutions; and $27.9 million—an increase of $2.2 million over last year—will be used in the national laboratories. Three-quarters of the increase in the university program will be directed toward work required for the acquisition of specific data needed in the Commission's direct program, and one-quarter will cover increased costs of basic research. The increase costs of the national laboratories result from the operation of facilities which are just being completed and from applied work urgently needed by other divisions of the Atomic EnergyCommission.

Senator MAYBANK. How many universities do you have?

Dr. JOHNSON. I have not counted them up. We have contracts with almost all of the universities, large and small.

Senator MAYBANK. I do not know what your wishes are, but I would think that that would be a good thing for the record, to show that.

Senator THYE. I definitely feel that it would be good information, because too often the general public thinks that this is a branch of the Government that is just growing up by itself, and that we are not utilizing the existing educational facilities that exist in the land, and if the information is that you turn to the universities and the colleges to make use of the facilities they have, then they realize that the Government is not expanding itself beyond any believable capacity, or understandable capacity.

Senator MAYBANK. Now I beg your pardon, Senator. We put this in the record and the doctor has it in the justification sheets here. You will find it on pages 251 through 322.

Senator THYE. Then it is already in the record.

Senator MAYBANK. Yes.

Senator THYE. We have made reference to it a second time, then, but that is all right.

NATIONAL LABORATORIES

Senator MAYBANK. It is well to have it in the record. The national laboratories that you have now under your direction, that is what you referred to?

Dr. JOHNSON. The Research Division has work going on in all of the national laboratories except Los Alamos. All of the research work at Los Alamos is under the Military Application Division.

Senator MAYBANK. Will you appropriate the money for that?

Dr. JOHNSON. That does not go through the Research Division and it is not included in this part of the budget.

Mr. BOYER. The money for Los Alamos was included in Colonel Fields' presentation. You may recall that that came in under the weapons program.

Senator MAYBANK. What I am trying to say is that there is no duplication of funds between the Atomic Energy Commission labotories and the military laboratories.

Mr. BOYER. That is right.

Senator MAYBANK. What Colonel Fields said yesterday was what they were doing, but the money comes out of this money here.

Dr. JOHNSON. That is a part of the Atomic Energy Commission.

Senator MAYBANK. I just wanted to make the record clear because I understood you had a reimbursement agreement with the Army,

even as to employment, and as Mr. McCarthy said, there were some 28 or 58 such instances. Is there anything further, Doctor?

ALLOCATION OF RESEARCH FUNDS

Dr. JOHNSON. I could break down this $43 million request a little further. Of that $43 million, $15 million will be used to finance work at the universities and institutions, and $27.9 million goes to the national laboratories. Three-quarters of the increase over last year, which is $3.6 million in the university program, is going toward the acquisition of specific data which are needed in the direct program of the Commission.

Senator MAYBANK. What do you mean by "specific data?"

Dr. JOHNSON. For example, in building a reactor for a submarine, there may be a material that you want to use, for fuel or to clad a fuel rod, and you have to know how this material interacts with neutrons, and to determine that you have to make some measurements. You do not make these measurements in the reactor itself but you use an accelerator to produce some neutrons of the right energy, and the right range of energies, and then you measure what we call the cross section for interaction of the neutrons with the nuclear properties of the material. We are interested here in nuclear properties as well as the ordinary properties and materials.

Senator MAYBANK. Are there any further questions?

Senator THYE. I have no questions.

BUDGET INCREASES

Dr. JOHNSON. I might say that one-quarter of the increase for the university program goes toward expansion of the basic research program. Three-quarters is for the specific data.

Senator MAYBANK. How are those programs working out? To illustrate, is that for specific data, or is that for a study that they are looking toward something?

Dr. JOHNSON. I can give you an illustration of what has been done.

(Discussion off the record.)

Mr. BOYER. I think, Mr. Chairman, a great portion of this program is in the record now. If you care to ask more questions of the doctor, he will be happy to answer them, but we have practically all of it in the record.

Senator THYE. I have no more questions.

Senator MAYBANK. I think that we are happy to have the list of the institutions, and they are in the record.

RESEARCH FACILITIES

Dr. JOHNSON. I should mention that there is $6 million requested for modifications and new research facilities in this budget, for the research program.

Senator MAYBANK. Where will those facilities be put or is that in the record?

Mr. BOYER. That is covered in pages 851 through 858, which were made a part of the record. If you wish, we could now ask Dr. Shields Warren to summarize his biology and medicine program budget.

Senator MAYBANK. Dr. Shields Warren, will you come forward, please.

Do you have a statement, Doctor?

Dr. WARREN. I have a statement that I would like to submit for the record, and, in addition, to submit for the record from volume 1, pages 331 to 427, and from volume 3, the construction program from pages 871 to 874.

Senator MAYBANK. Without objection, that will be made a part of the record.

(The information referred to is as follows:)

STATEMENT OF DR. SHIELDS WARREN, DIRECTOR OF THE DIVISION OF BIOLOGY AND MEDICINE, UNITED STATES ATOMIC ENERGY COMMISSION

BIOLOGY AND MEDICINE PROGRAM

A net reduction in the total program in biology and medicine is planned for fiscal year 1953. Total costs in fiscal year 1952 are expected to reach approximately $27.3 million, while a program of $25.1 million is planned for fiscal year 1953. This reduction of $2.2 million is mainly attributable to the completion in fiscal year 1952 of certain major construction objectives enabling a commensurate leveling off in fiscal year 1953.

Operations budget increase

A slight increase in the operations portion of the budget is planned, however. Operating costs in fiscal year 1952 should reach $23.3 million as compared with $24.6 million planned for fiscal year 1953. This increase of $1.3 million is due principally to the fact that an additional $850,000 will be needed to operate the new Argonne Cancer Hospital which should be getting into full operation in fiscal year 1953. The remainder of the increase is traceable to the somewhat augmented requirements of staff recruitment at the many sites to previously planned levels and the increments of rising costs experienced throughout the program.

Not reflected in the increased operating costs planned for fiscal year 1953 is an increase in the number and variety of responsibilities assumed by the Commission in the field of biology and medicine. In addition to the growing complexity of the hazards to health arising from the expansion and diversification of the production and weapons program, the Commission's requirements for general medical services have increased in several respects. With the opening of the continental test site, increased participation in weapons tests on the part of the medical staff has become essential in order to insure that experiments may be continued without danger to any region of the country.

Atomic data requirements of Government agencies

During the past year it became increasingly apparent that a number of Government agencies have present and urgent requirements for data from field tests of atomic weapons. It was obvious, however, that strong central coordination would be required if these data were to be obtained in an orderly and economical fashion. For these reasons, test planning committees were established and such agencies as the Public Health Service, Department of Agriculture, Public Buildings Service, Federal Civil Defense Administration, and others are now represented on the committees. The objective of the committees is to screen and plan experiments in the fields of biology and medicine and protective construction for inclusion in the weapons tests. While these tests are primarily part of the weapons development program, they offer, nevertheless, unique opportunities for realistic biomedical experiments of importance to national defense. Although no specific funds are earmarked in this budget for biomedical experiments as such, the additional responsibility for this program has imposed a noticeable burden on the time of the staff and will undoubtedly require and merit more specific financial assistance in the future.

Mobile reactors

The prospect of mobile reactors soon entering the operational stage has pointed up the critical nature of the problem of exposure of aircraft and submarine crews to chronic irradiation. The possibility of human failure and the subsequent loss of the entire equipment has underscored the importance of our research on the

nature and treatment of the radiation syndrome. Our studies of the effects of radiation on physical and mental endurance are directly applicable to these problems. At present, modification in the content of the program rather than increased costs will serve to meet these needs.

Radiological warfare

The AEC, in collaboration with the Department of Defense, is continuing its program in the field of radiological warfare. This study involves both external and internal hazards according to the agents used and their mode of dissemination. Many aspects of the metabolic uptake of fission products and related substances as studied in plants and animals are directly related to problems of radiological warfare. Answers are being sought to such questions as: When are foods unsafe to eat? What are the practical means of detecting and protecting the public from foods contaminated by radiation? How can contaminated foods be made safe? All of these have ultimate significance in terms of their effects on man, and investigations of them are being actively pursued in the research program in biology and medicine.

As may be seen, the program of biology and medicine falls into diverse fields of interest. However, these varied activities have not been allowed to detract from the basic mission of the program: the protection of the health and safety of the people. The Commission's special concern is radiation. The effects of radiation are exceedingly complex and may vary from genetic changes involving future generations to the shortening of life expectancy and the incitement of cancerous changes in the bodies of individuals in the present generation. The fundamental complexity of these problems is enhanced by their widespread ramifications. Intelligent and effective treatment and protection will come only from an understanding of the effects phenomena—how ionizing radiation reacts with the cells of the body to produce basic changes.

It is upon such long-range values as those discussed above, and upon fundamental scientific knowledge growing out of long-term research, that our continued progress in the field of biology and medicine will largely depend.

In recognition of this fact the program of research in biology and medicine has been carefully developed over the past several years. The program contemplated for fiscal year 1953 represents further refinements in augmentation of the basic plan.

Operating Program Summary and Narrative Statement

Biology and medicine program

	1951 actual	1952 estimate	1953 estimate
Research and development:			
Medicine research:			
Cancer	$1,351,269	$1,794,500	$2,758,000
General	6,300,225	6,480,400	6,419,000
Biological research	8,771,891	10,060,100	10,344,000
Biophysics research	3,415,294	4,087,500	4,314,000
University and special training	777,229	863,000	765,000
Total, research and development accrued cost basis	20,615,908	23,285,500	24,600,000

SUMMARY STATEMENT

The Commission's budget for fiscal year 1953 contains an estimate for $24,600,000 to finance the research program of the Division of Biology and Medicine. The objectives of this program are (1) to establish and supervise measures to guard the health of atomic energy workers and the general public from hazards arising from atomic energy operations; (2) to utilize radiation to study and treat diseases, including cancer, and to develop means to minimize radiation hazards; (3) to support fundamental research on the effects of ionizing radiations on living organisms; (4) to develop the use and application of radioactive materials as a research tool in the fields of biology; (5) to develop radiation detection and monitoring instruments; (6) to provide technical data on the effects of atomic bombs through liaison with FCDA and other agencies, and (7) to coordinate AEC civil defense activities and to formulate and review design criteria for AEC protective construction.

To further these ends research will be continued on an ever-increasing variety of radioactive and nonradioactive hazardous materials; special emphasis will be placed on studies leading to improvement in methods of protection from radiation. There will be further exploitation of slow neutrons from an atomic pile in the treatment of cancer. More data will be accumulated on the genetic effects of ionizing radiation, and effort will be increased in the exploitation of atomic energy in the biological and agricultural sciences. Work will continue on increasing the reliability of permissible levels of exposure to radiations and radioactive substances, and of health physics instruments. The formulation and accumulation of design criteria and data on radiation, blast and thermal effects will be emphasized; and AEC emergency monitoring, and instrument-source loan programs will be continued together with an acceleration of liaison activities.

Medical research will be pursued vigorously with considerable effort to be expended on many existing projects and some major emphasis placed on new activities. Noteworthy accomplishments during the past year included work done at the Argonne National Laboratory and at the University of Chicago on spleen and partial body shielding. Glandular and embryonic transplants as methods of protecting experimental animals against whole body radiation showed considerable progress. It is now possible to so treat an experimental animal that he can be assured of surviving twice the LD 50 dose of radiation.

The first three human patients ever to be treated in an atomic pile were irradiated at Brookhaven for brain tumors.

A program to evaluate currently available methods of treatment for whole body radiation injury was established at the University of Rochester AEC project.

The first 24 of a large group of individuals who received radium intravenously some 20 years ago have undergone preliminary study at the Argonne National Laboratory.

During fiscal year 1953 major activities will bear heavily on:

(1) Methods of protection against and treatment of whole body radiation injury;

(2) The metabolism of the blood-forming organs with particular reference to recovery of these tissues from radiation injury;

(3) The study of thermal burns from atomic blasts;

(4) The biochemical sequelae of ionizing radiation, and

(5) The problem of chronic beryllium poisoning.

Radiobiology, or the biological effects of radiation, is receiving major emphasis in the Commission's biology research program. The use of radioactive isotopes is making it possible to secure an accurate understanding of many important biological processes, from the synthesis of proteins which are the basic substances of living cells, to photosynthesis which is the basic reaction by which plants manufacture sugars and starches from water and carbon dioxide in the air.

To understand the hazards of atomic warfare, it is necessary to study both the immediate effects of radiation on living tissues and also the possible effects on future generations through changes in the genes or units of heredity carried in the reproductive cells. To this end broad studies are being supported on genetic effects of radiation in lower animals, mammals, and plants, as well as on the normal rate of mutation in humans.

The biology group is responsible for research in radiobiology at the AEC national laboratories and other installations, and for many other important research projects in college and university laboratories throughout the country. Measurable progress has been made in a better understanding of important biological reactions concerned with the injurious effects of certain fission products. From such data it should be possible eventually to determine individual tolerance levels as well as possible effects on populations. These can be used for over-all planning and for health and safety regulations.

In the biophysics research program, emphasis is placed on the problem of furnishing operating personnel and general populations with adequate protection against radiation and radioactive materials, consistent with known health standards and efficiency of operation of atomic energy plants. Permissible levels of exposure to 14 common radioactive materials have been specified for AEC operations, based on national and international agreements and on data largely obtained through AEC research activities.

Through continued biophysical research, progress is being made in the more accurate determination of permissible human exposure to radium, plutonium, and strontium. Permissible contaminations under emergency conditions have been determined. Progress is being made toward the development of a realistic waste disposal policy. Improved instrumentation for measurement of beta rays

and neutrons will assist in protection against external radiation in the vicinity of high energy accelerators. Country-wide monitoring programs protect populations and sensitive industries against the build-up of radioactivity due to plant operations and continental bomb tests. Major activities in biophysics will continue to be directed along these lines.

Also included in this program are the responsibilities of the Civil Defense liaison group. This activity includes the following: (1) Implementation of the Commission's policies in civil-defense matters; (2) professional advice on standards of protective construction for AEC and FCDA; (3) facilitation of the civil defense program of the FCDA through special facilities of the AEC where practicable; and (4) technical assistance in the preparation and review of FCDA publications as requested.

The accumulation of data on radiation, blast and thermal effects on structures will be continued. The AEC emergency monitoring, and instrument-radioisotope loan programs will be maintained.

The radiation instruments development group has as its primary function the coordination of Commission-wide radiation instrumentation requirements, and instrument development activities. It has been instrumental in establishing sources of supply for instruments needed not only by the AEC but by research and biomedical investigators at college and university laboratories and other research institutions, radioactive ore prospectors, and civil defense monotoring teams. Information concerning commercially available instruments is compiled into a radiation instruments catalog. A close working arrangement has been established with the National Bureau of Standards for testing new products and providing special instrument tests and calibration service to all AEC installations. Contracts with industrial research groups have been initiated to design and develop better instrument components and equipment; for example, photomultiplier tubes for scintillation counters, high voltage batteries, high speed recording devices, pulse height analyzers, etc.

The group will accelerate its instrument program coordination activities and will render greater staff assistance to all divisions in the review of instrument requirements. Increasing emphasis is to be placed on standardization of instruments.

Detailed Justification of Operating Costs

Biology and Medicine Program, Research and Development Subprogram

Medicine research, cancer category

Medicine research, cancer:	
1951 actual	$1,351,269
1952 estimate	1,794,500
1593 estimate	2,758,000

Summary

General statement

The cancer research program of the Atomic Energy Commission will continue to be centered about three major activities: the Oak Ridge Institute of Nuclear Studies, the Argonne Cancer Hospital, and the Brookhaven National Laboratory.

Programs in these areas were organized because of the close proximity to nuclear reactors whose unique products offered the greatest hope for utilizing atomic energy in a successful attack on the cancer problem, Much of the work which is labeled cancer research actually has a substantial importance to the Commission's operating responsibilities since it yields data on the biological effects of radiation upon human beings. The general trend is away from the initiation of new cancer research projects, except where a unique application of radioisotopes or other forms of atomic energy is involved, or where data on the exposure of human beings to high levels of radioactivity may be obtained. The outstanding contribution of the past year in the cancer therapy field was made when the first application of pile-generated neutrons in the treatment of brain tumors was accomplished at Brookhaven. The major Commission support of cancer therapy outside of the intramural programs mentioned above will be through the free isotope distribution program.

The apparent increase in program represents the development of operating costs for facilities and programs authorized in previous years and does not indicate an increased scope of the cancer program.

Activity and location	1951 actual	1952 estimate	1953 estimate
MC-1 Argonne Cancer Hospital	0	$300,000	$1,150,000
MC-2 Argonne National Laboratory	$60,889	51,000	51,000
MC-3 Brookhaven National Laboratory	198,053	220,000	242,000
MC-4 Oak Ridge Institute of Nuclear Studies	447,422	450,000	525,000
MC-5 San Francisco Hospital (University of California)	57,714	200,000	220,000
MC-6 University of California at Berkeley	88,615	0	0
MC-7 Free distribution of isotopes	386,585	450,000	450,000
MC-8 Off-site university research program (cancer)	111,991	123,500	120,000
Total, medicine research, cancer, accrued cost basis	1,351,269	1,791,500	2,758,000

DETAIL

	1951 actual	1952 estimate	1953 estimate
MC-1 Argonne Cancer Hospital	0	$300,000	$1,150,000
Man-years (scientific only)	0	20	57

It is anticipated that the Argonne Cancer Research Hospital will be completed and ready for operation before the end of fiscal year 1952. This facility will have 58 beds for patients in addition to extensive laboratories for the handling of radioactive materials in the treatment and study of cancer, as well as a high-energy betatron and a powerful radiocobalt source. Experimental studies will be done on animals as well as man. The objectives of the research program call for cooperation between the University of Chicago, the Argonne National Laboratory, the Argonne Laboratory participating universities, and other related activities of the Atomic Energy Commission. The program of research at this facility is not completely firmed up as yet, but it is planned that a good part of the work on the effects of spleen shielding, embryo and spleen brei and the like, on the amelioration of whole body radiation injury will be conducted in this facility during the next few years. This work which involves an as yet unidentified substance capable of stimulating rapid regeneration of damaged bone marrow is of great importance in the field of cancer because of the fact that X-rays and the nitrogen mustards so commonly used in cancer treatment today are active bone marrow depressants. It is also anticipated that an appreciable share of the clinical studies of individuals who some years ago received radium therapeutically will be undertaken here in an effort to elucidate the carcinogenic effects of radium burden as well as determining the maximum permissible body burden, in humans, of this material.

	1951 actual	1952 estimate	1953 estimate
MC-2 Argonne National Laboratory	$60,889	$51,000	$51,000
Man-years (scientific only)	2	2	2

Mammalian tumors are valuable tools in investigations of radiosensitivity because their growth is easily quantitated and their response to radiation is well known. These studies are adjuncts to those in physiology, biochemistry, and cytology. Studies of changes in radiosensitivity of tumors as induced by chemical substances such as cysteine and methylene blue will be continued. This work lends itself to a possible extension of results to general problems of radiosensitivity and radioresistance.

	1951 actual	1952 estimate	1953 estimate
MC-3 Brookhaven National Laboratory	$198,053	$220,000	$242,000
Man-years (scientific only)	2	5	6

A limited number of individuals with cancer of the thyroid gland have already been studied particularly from the standpoint of the effects of radioiodine on various tissues and functions of the body. This work and the work with other can-

cers treated with radioactive isotopes will be continued in the future. The effects of isotopic and neutron radiation on the growth of nonspecific virus in tumors will be studied. Mice with transplantable tumors will be studied for specific tumor antibody production and for total and passive immunity. Particular emphasis will be placed on the effect of radioactive isotopes on the mechanisms involved in nitrogen concentration. Patients will be studied in varying stages of nitrogen depletion and repletion both before and after the administration of therapeutic doses of radioactive isotopes. Comparisons will be made between patients with cancer and patients without cancer. Further exploitation of slow neutrons from the pile in the therapy of brain tumors will be done.

	1951 actual	1952 estimate	1953 estimate
MC-4 Oak Ridge Institute of Nuclear Studies	$447,422	$450,000	$525,000
Man-years (scientific only)	[1] 27	[1] 28	[1] 29

[1] Includes 20 man-years of nonreimbursable personnel, such as medical school consultants, etc.

In late fiscal year 1950 this cancer facility was completed and the first patients admitted for treatment. The hospital has available beds for the treatment of 30 patients and appropriate laboratory facilities for the exploitation of atomic energy in the study and treatment of cancer. Major emphasis at the present time is being placed on radiogallium because of its affinity for bone cancer. Extensive work is already under way on the toxicity and pharmacological behavior of various gallium compounds in the therapeutic dose range. Other work is under way in the preparation of radioantimony compounds and iodine and cobalt labeled compounds for experimental work in animals in the treatment of blood diseases. Work is also in progress on various methods of injecting radiogold with or without the necessity of surgical approaches. The 1,000 curie telecobalt source will go into operation in fiscal year 1952 and be fully utilized in fiscal year 1953.

	1951 actual	1952 estimate	1953 estimate
MC-5 San Francisco Hospital (University of California)	$57,714	$200,000	$220,000
Man-years (scientific only)	3	8	8

This project has been carried on during the past 2 years on a limited scale by a group who have made important contributions on the effects of radiations on the blood and blood-forming organs, both in animals and in humans. They have also done pioneer work in the application of radioiodine to diseases of the thyroid gland and in the study of thyroid physiology. During fiscal years 1952 and 1953, they will continue morphologic studies of the blood cells on patients receiving various types of radiations. They will extend these studies to include fragility studies as determined by the use of supersonic waves and will be developing better methods of imbedding blood for tissue sections for study. Microchemical chromatographic and ultraviolet microscopic techniques will also be employed in these studies. The work with radioiodine will continue with particular emphasis on solving the problem of how to determine the size of the thyroid gland in a patient, which is a basic problem delaying advances in the application of radioiodine to thyroid disease. It is planned to use scanning techniques employing crystal counter equipment in this study. Further studies will be made of the distribution of iodine 131 between the serum and red blood cells in patients with different thyroid conditions.

During the fourth quarter of fiscal year 1951, the building to house the 70 MEV synchrotron was completed. Considerable time will be spent on correcting design and function of the instrument. It is hoped that beams of both X-rays and beta rays will be available from the synchrotron in the next few months at which time exposure of animals will commence. From then on a major part of this project will be concerned with exploiting the rays from this instrument both in the treatment of disease and in the study of radiation effects on animals and humans.

	1951 actual	1952 estimate	1953 estimate
MC-7 Free distribution of isotopes	$386,585	$450,000	$450,000

On April 1, 1948, the AEC allotted $50,000 to pay the production costs of radioactive isotopes and to allow distribution at a reduced cost for therapy and research in the cancer field. With the demonstrated usefulness of radioisotopes in cancer therapy the utilization of isotopes spread from a few major institutions to hospitals and clinics throughout the country. Actual costs in 1951 were $386,585. The level of expenditures for this purpose for 1952 and 1953 is expected to stabilize at $450,000 per year.

It should be emphasized that the free isotope distribution program represents the major AEC contribution to cancer therapy outside of the special cancer facilities within Commission installations.

In general, it may be stated that the AEC support of cancer research and therapy is limited to programs involving specialized and unique uses of radioactive byproducts of atomic energy and does not include research in the broad field of cancer which more properly falls within the purview of other public and private agencies.

	1951 actual	1952 estimate	1953 estimate
MC-8. Off-site university research program (cancer)	$111,991	$123,500	$120,000

The AEC medical research cancer program in outside institutions consists of five research contracts, each of which is concerned with a unique application of radioisotopes to cancer diagnosis and therapy. It is considered desirable to permit this program to stabilize at the level of approximately $120,000, to permit the exploration of new and promising developments in the field. It is expected that new projects which will arise can be financed by reductions in the scope of the existing five projects as they run their course.

The estimated costs for the activity by separate projects are listed below:

Institution	Project	Fiscal year 1951	Fiscal year 1952	Fiscal year 1953
Meharry Medical College	Use of radioactive gold in treatment of tumors.	$60,074	$60,264	$56,000
University of Minnesota	Localization of radioactive materials in the nervous system.	16,040	25,294	19,701
Do	Zirconium as radiopaque media	1,514	0	0
Ohio State University	Use of radioisotopes for cancer therapy	22,940	25,442	21,250
Washington University	Use of Gamma ray as a therapeutic agent of carcinoma.	11,423	12,500	16,945
Unallocated for renewals, extensions, or new research projects.		0	0	6,104
Medicine cancer research contract support.		111,991	123,500	120,000

Medicine research, general

Medicine research, general:

1951 actual	$6,300,225
1952 estimate	6,480,400
1953 estimate	6,419,000

SUMMARY

General statement

The increase in scope of the atomic energy program, both in the production of fissionable materials and the development of new high energy reactors, along with the heightened tempo of national defense, and the possibility of atomic bombing and radiological warfare have all called for increased emphasis on the understanding and treatment of radiation sickness of and flash burns caused by atomic bombing.

Several of the specific accomplishments of the medical research program in the field of treating radiation injury have been mentioned in the introductory statement. Research on the treatment of flash burns which constitute one of the major types of injury in atomic explosions is continuing on a firm footing now that Operation Greenhouse data is available.

Pilot studies and screening studies of pharmacological agents for possible effectiveness against radiation injury are most economically carried out using small animals such as rats and mice. However, before these useful agents, of which several recently have been developed, can be used in the treatment of radiation injury in human beings, they must be carefully evaluated in larger animals whose physiological behavior more closely resembles that of man. This has brought about the need for increased facilities for working with dogs and other larger animals and has necessarily increased unit experimental costs.

The developments of the past 2 years in the treatment of radiation sickness have been sufficiently promising to permit us to hope that in the not too distant future it will be possible to protect human beings against doses of radiation twice as great as those which at the present time are known to be lethal.

The following detailed statements again point up the emphasis being placed on research, both basic and applied, oriented to solving problems of protecting persons against the harmful effects of materials both radioactive and nonradioactive.

Activity and location	1951 actual	1952 estimate	1953 estimate
M-1 Argonne National Laboratory	$68,284	$115,000	$140,000
M-2 Brookhaven National Laboratory	682,184	800,000	826,000
M-3 National Academy of Sciences (Atomic Bomb Casualty Commission)	1,465,878	1,300,000	1,100,000
M-4 University of California at Berkeley	295,427	180,000	187,000
M-5 University of California at Los Angeles	214,313	235,400	235,000
M-6 University of Rochester	1,070,262	1,050,000	1,041,000
M-7 Off-site university research program (medicine)	2,503,877	2,800,000	2,890,000
Total, medicine research, general accrued cost basis	6,300,225	6,480,400	6,419,000

DETAILS

	1951 actual	1952 estimate	1953 estimate
M-1. Argonne National Laboratory	$68,284	$115,000	$140,000
Man-years (scientific only)	2	3	4

The reliability of estimates of toxicity of radioactive elements to man is no greater than the reliability of the extrapolations from experimental animals to man. Since the instances of radioelement poisoning in man are few except in the case of radium, human equivalences must be calculated in terms of this element. Recent examination of available data raises questions as to the validity of previous studies. This group has available for study now more than 40 individuals who received known amounts of pure radium chloride. It is probable that this number will reach 100 before long. This project includes the collection of samples and examination of these individuals which involves rather complete clinical studies and difficult physical measurements of radioactivity. The relationship between calcium metabolism and radium metabolism is being reinvestigated and the role of mesothorium in the development of radium disease is being evaluated. The clinical side of this work will be transferred to the Argonne Cancer Hospital when that facility becomes available.

	1951 actual	1952 estimate	1953 estimate
M-2 Brookhaven National Laboratory	$682,184	$800,000	$826,000
Man-years (scientific only)	12	18	19

During 1952, it is hoped to complete the general coverage of research fields in this facility by the addition of a physiology group. A number of patients, children from 1 to 6 years of age have already been admitted for study, and important observations on protein and lipid metabolism will be made. Work has been begun and will continue during 1952 and 1953 on the effects of isotopic and neutron radiation, on the susceptibility of animals to viral and bacterial infection, on the development of immunity, on the virulence of viral agents, and on the degree of immunity already present in the animal at the time of infection. Studies begun in late 1950 on inflammatory processes associated with bone

fractures and with the presence of internal irradiations with respect to the formation of new protein will be continued. Stable isotopic nitrogen and S–35 will be used to label the new protein and to determine its distribution in the organs, tissues, and in blood. Studies will be undertaken on the effects of gamma radiation on the type specificity of the pneumococcus with particular reference to the effect of radiation upon the transforming substance (desoxyribonucleic acid) of type III pneumococcus. Tagged botulinus toxin will be employed to study the exact mode of action of this substance in animals. The Van Slyke carbon combustion method has been adapted to permit the determination of radioactive carbon in the carbon dioxide produced and measured in the Van Slyke gasometric apparatus. This particular project is correlated with carbon 14 work going on at Argonne and Los Alamos. Short lived iodine isotopes available locally are being used in the treatment of certain thyroid diseases to determine whether or not there is any advantage over currently available iodine 131. Studies have been under way since the first of calendar year 1950 on the effects of kidney function of radioisotopes which are primarily excreted in the urine. This group is particularly well versed in renal physiology and it is expected that significant observations on radiation effects will be forthcoming. The use of sodium 24 is being exploited in the study of edema and extracellular fluid. In edematous patients with thyroid and kidney disease, it is expected that this project will gain important information on the capacity of the body to conserve its sodium store under conditions of sodium deficiency in patients with and without kidney disease. These studies of body fluids also involve the use of tritium. Observations with this technique are being correlated with work on tritium currently under way and projected at Argonne and Los Alamos.

	1951 actual	1952 estimate	1953 estimate
M-3 National Academy of Sciences (Atomic Bomb Casualty Commission)	$1,465,878	$1,300,000	$1,100,000
Man-years (scientific only)	83	81	80
United States nationals	22	20	15
Japanese	61	61	65

The survivors of the atomic blasts at Hiroshima and Nagasaki constitute the only sizable group of otherwise normal human beings who have been exposed to appreciable amounts of whole body ionizing radiation. This program is a long range study of these survivors to determine: (1) the development of late evidence of injury among the survivors, and (2) the genetic changes, if any, in the offspring of those exposed.

All known survivors within 1,000 meters of the hypocenter have been examined and will be given complete medical examinations annually. To date, about 10 percent of these people have developed radiation-induced cataracts. Periodic examinations will be made to check on progression of existing cataracts as well as searching for new cataracts.

The preliminary results of a leukemia survey instituted in 1951 indicates that the incidence among the 1,000 meter survivors at this time is about 12 times that in the general population. This survey will continue in order to determine the frequency, age, and time of onset of radiation-induced leukemia.

A general screening of the radiation exposed and control populations will continue.

The long-range genetics program continues with about 650 newborns in Hiroshima and 750 in Nagasaki being examined each month. About 50,000 newborns have been examined to date, but years more of study will be required before definite conclusions can be drawn as to the genetic effects on humans.

Well equipped facilities have been completed at Hiroshima and Nagasaki. The number of patients given complete medical examinations have increased to over 60 per day. This number will be increased to about 100 per day when all laboratory facilities in Hiroshima have been centralized at one site and quarters provided for Allied personnel.

	1951 actual	1952 estimate	1953 estimate
M-4 University of California, Berkeley	$295,427	$180,000	$187,000
Man years (scientific only)	10	6	6

The medical research program at Berkeley places a strong emphasis upon studies of the mechanism of the action of ionizing radiation upon human systems. The research takes full advantage of the presence of a variety of high energy particle acceleration which are available only in Berkeley, and in addition makes use of radio-active isotopes as radiation sources in diagnosis and therapy.

The program is extensive and includes studies of regional circulation, thyroid function, blood mixing rates, electrolyte space, water balance, experimental isotope irradiation therapy. The program also includes investigations of the influence of radiation upon blood lipoprotein levels, the rate of red blood cell formation, and upon nucleoprotein formation and turn-over.

The research effort is supported by 6 faculty members, 9 research associates, 13 research fellows and 62 graduate students. An important part of the program involves the collection of medical information on the health and physiological status of radiation laboratory personnel, as a part of the health protection program, and as a source of data in a long-range project to ascertain possible effects of small doses of radiation on human beings.

	1951 actual	1952 estimate	1953 estimate
M-5 University of California, Los Angeles	$214,313	$235,400	$235,000
Man years (scientific only)	24	24	24

(*a*) *Pharmacology, toxicology.*—This group will continue to have a major interest in studying the blood coagulation defects caused by whole body irradiation. In addition, they will attempt to determine the relative merits of oral and intravenous feeding during the active stages of the syndrome of whole body radiation injury, and plan to study the causes of the blood-pressure changes following irradiation. Another section is gathering valuable data in the transport of five radioactive particles from the lung to other parts of the body.

(*b*) *Medicine, physics.*—Continuation of a limited study of direct blast effects both as to physical nature and physiologic damage. It is also planned that this group undertake studies on the inhalation of gross fission products. Work on instrumentation will continue with particular emphasis on localizing and measuring gamma rays in vivo.

	1951 actual	1952 estimate	1953 estimate
M-6 University of Rochester	$1,070,262	$1,050,000	$1,041,000
Man years (scientific only)	72	80	80

The University of Rochester project consists of several sections, each of which applies special skills to the solution of problems of more or less direct interest to Commission activities.

Industrial Hygiene Section attempts to obtain specific answers to practical problems encountered in the field, having to do with the nature and control of the toxicological effects of certain chemicals, both radioactive and nonradioactive. Specifically, extensive work has been done in the past on uranium, beryllium, and thorium with increased emphasis on zirconium, plutonium, and polonium. Beginning in fiscal year 1951 less emphasis has been placed on uranium and beryllium.

Radiology section.—This section devotes itself to fundamental studies on the biological effects of irradiation as produced by low- and high-voltage X-rays and high-energy neutrons. Long-term studies on animals are under way involving both large and small doses of radiation. This work continues to be coordinated with the over-all AEC program on chronic effects of irradiation currently projected by the Biology Branch at certain of the national laboratories, AEC projects, and outside institutions. Work will continue on amino acid utilization and protein formation in health and disease using radioactive-labeled amino acids as tools. Particular stress during the next 2 years will be placed on the formation of blood proteins and studies on the alterations of protein metabolism associated with normal aging and aging induced by exposure to ionizing irradiations.

Flash-burn section.—This is a high-priority project in which, during the past 2 years, methods have been perfected for producing experimental burns comparable to those resulting from an atomic blast. During the next 2 years, studies will be made of the exact nature of these burns and effective means will be sought for

protecting against and treating flash burns in both nonirradiated animals and animals irradiated at time of burning.

Acute radiation studies.—Currently very significant work is under way on the problem of acute irradiation with particular emphasis on the value of antibiotics as anti-infection agents. Furthermore, certain observations suggest the possibility that some of these drugs may also act as detoxifying agents. These studies will be extended and during the fiscal years 1952 and 1953, definitive studies on dogs given midlethal doses of radiation are being made in an effort to determine the usefulness of standard supportive measures currently used in medical practice and contemplated in the treatment of radiation casualties in the event of atomic warfare.

Other activities.—This project carries on an active teaching and training program in biophysics and cancer in cooperation with the University of Rochester Medical School cancer program, as well as training physicians in the general geographical area in the use of radioiodine and other radioisotopes in the treatment of cancer. It administers the newly established postdoctoral fellowship program in industrial medicine.

	1951 actual	1952 estimate	1953 estimate
M-7 Off-site university research program (medicine)	$2,503,877	$2,800,000	$2,890,000

The original research program as authorized under the Atomic Energy Act, and by the Commission, was rather broad in scope and included a number of projects directed toward the peacetime utilization of atomic energy, but not necessarily related to the main-line problems and operating interests of the Atomic Energy Commission. These projects involved the use of atomic-energy substances. The purpose was to encourage and promote medical research using atomic-energy substances in the development of trained scientists and knowledge in this field. The trend is now to divert more research effort toward the solution of current Commission operational problems. The major portion of the requested increase in the direct-research medicine program is occasioned by the need for creating and operating several animal experimental programs dealing with the determination of the permissible human burden or tolerance for plutonium and other radioactive emitters involved in production and operation activities. Included in this is the University of Utah plutonium-toxicity project, and an additional project which was activated during fiscal year 1951 on the effects of inhaled radioactive emitters upon the human body. The preliminary work on these problems has been carried out on mice, rats, and smaller animals. In order to permit extrapolation of these data to the problems of human beings exposed to these materials in Commission operations it is necessary to very carefully determine the tolerance levels in medium-size animals, such as dogs. Such experiments require the facilities of first-class medical schools, the desirability of remoteness of location (due to radioactive materials to be used), and extensive animal quarters (for the housing of 200 or more dogs for an extended period). This combination is not available in any Commission installation. Additional emphasis is being placed on investigations oriented toward improving the treatment of acute radiation injury. Here again the work must be performed on larger animals such as dogs. These investigations involve unit costs considerably above those which prevailed for the earlier pilot work on smaller animals.

The estimated costs for the activity, by separate projects, are as follows:

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
American National Red Cross	Research in field of blood-fractionation.	$99,200	0	0
Baylor University College of Medicine.	Chemistry and metabolism of radioactive sulfur oxides.	7,822	0	0
Beth Israel Hospital (Harvard)	The use of I-131 in treatment of heart diseases and follow-up studies on biological effects of radiation.	38,344	$14,300	$12,000
Boston University	The relationship of the hypophysis to iron metabolism.	3,966	0	0
Do	The effect of irradiation on the functions of small blood vessels of the hamster and the frog.	9,712	35,000	24,237

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Boston University—Continued	The effects of sublethal doses of ionizing radiation on physical performance of dogs; related biochemical and pathological studies.	0	$45,000	$40,000
Botwick, Marvin	Furnishing kits for determining blood group and research in development of cross-matching method.	$11,521	903	0
California, University of	Investigations of the dietary effects of radioactive strontium, calcium, and phosphorus (dental).	4,100	7,601	0
California, University of	Use of radiocarbon in studies on carbon monoxide physiology and implications concerning respiro-circulatory physiology.	9,335	0	0
Cedars of Lebanon Hospital	Relationship of flavanoid structures to radiation protection.	2,767	0	0
Chicago, University of	Bacteriological aspects of radiation sickness.	33,336	48,208	50,000
Do	Metabolism of nervous system as studied with radioisotopes.	19,740	0	0
Do	Histochemical study of cement substance of the normal and abnormal optic lens.	12,900	16,500	18,000
Do	Investigation of the mechanism of antibody synthesis by the tracer technique.	3,480	5,346	5,000
Do	A study of the carcinogenic effect of irradiation therapy on peptic ulcer.	8,100	13,750	10,000
Do	Radiosensitivity of the lymphocyte	3,400	5,000	7,000
Do	The effect of localized X-irradiation on antibody formation and antigen localization. The site of antibody formation.	0	19,000	20,000
Children's Medical Center of Boston.	Effects of radiation during infancy and childhood on the growth of the spine.	1,500	0	0
Cincinnati, University of	Iron metabolism	2,000	0	0
Do	Research on the biological effects of beryllium and its compounds.	32,361	29,147	$0,000
Colorado, University of	Research on the infrared absorption spectra of nucleic acids, amino acids, and related compounds.	8,088	8,802	8,000
Do	Normal and radiation-induced metabolism in viruses and their host cells.	25,540	25,000	25,000
Do	Bacteriophage and radiation mechanisms.	38,557	30,000	20,000
Columbia University	Use of radioactive iodine in developing quantitative-assay method for thyrotropic hormone.	2,234	0	0
Do	Biological effects of radiation from excessive amounts of radioiodine.	6,318	0	0
Do	Effect of exposure to radioactive material and to X-ray irradiation on nerve tissue.	8,686	12,000	12,000
Do	Study of changes in permeability of normal, poisoned, and irradiated nerve fibers.	7,500	10,000	10,000
Do	The turn-over of specific proteins, protein fractions, and nucleic acids in normal and malignant human testis and kidney.	8,073	16,146	13,000
Creedmore Institute for Psychobiologic Studies.	Investigations on the relationship of human skin types to blood types and related studies in the mechanism of thermal injury.	0	23,455	20,000
Denver, University of	Physiologic and pathologic effects of radioactive cobalt.	7,526	6,000	5,000
Duke University	I. Training program	0	9,761	4,000
	II. Turn-over of organic phosphates in the kidney.	34,869	17,669	12,500
	III. Studies of electrolyte and fluid balance in health and disease.	0	7,246	5,246
Duke University	Study of the metabolism of the human bone marrow.	12,042	11,021	10,000
Georgetown University	Use of chelating agents in the study of mineral metabolism, with particular reference to bone.	6,850	5,750	5,000
Georgia, University of	The effects of nutritional deficiencies on the synthesis of phospholipids and nucleoproteins in the rat.	5,867	6,990	6,000
George Washington University	Studies of the effects of radiation on the biosynthesis and degradation of nucleoproteins and its modification by various agents.	6,905	11,212	10,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Hahnemann Medical College	A study of nutritional and other factors involved in radiation injury and resistance to radiation injury.	$7,000	$11,000	$11,000
Harvard University	I. Research on biological, medical and biophysical problems. Isotope technique research; use of isotopes on medical problems. II. Use of isotopes in study of metabolism of organic substances in mammalian tissue. III. Use of isotopes in therapeutic and diagnostic agents. IV. Study of metabolic activities of living organisms by means of suitable isotopes.	103,402	120,000	130,000
Do	Research in field of blood fractionation	0	50,000	50,000
Do	Destruction of red blood cells, in hemolytic anemia.	13,970	0	0
Do	Metabolism of the teeth	13,954	10,000	10,000
Do	Effects of radiation upon developing rat embryos.	9,561	10,000	10,000
Do	Production of cataracts by neutrons and other radiations.	12,025	10,979	11,000
Do	Stereophotography of anterior segment of eye with special reference to crystalline lens.	5,942	11,883	0
Do	Assembly and delivery of 3 cameras for cataract studies.	0	4,598	0
Haskins Laboratories, Inc	The microbiological assay of nucleic acid constituents produced by radiation injury.	12,701	7,401	6,000
Henry Ford Hospital	Chemical sterilization of blood and plasma with nitrogen mustard.	12,825	20,850	4,000
Illinois, University of	Effects of radiation of the gastric mucosa.	5,170	5,485	4,000
Institute for Cancer Research (Lankanau Hospital).	Origin and fate of amino acids in plants and animals.	11,000	11,000	10,000
Interior, Department of	Inflammability and explosibility of metallic powders of uranium, thorium, zirconium, titanium, vanadium, and beryllium.	4,000	0	0
Iowa, State University of	A quantitative and morphologic study of radiation induced cataracts.	10,300	10,300	18,000
Johns Hopkins University	Metabolism of phosphorus in virus-host systems.	10,771	18,792	15,000
Johns Hopkins University School of Medicine.	(a) Studies of the absorption, utilization and excretion of vitamin B_{12}, using B_{12} containing radioactive cobalt (Co_{60}). (b) Synthesis of compounds with vitamin K activity labeled with radioactive carbon (C_{14}) for use in tracer studies with vitamin K.	0	4,671	4,500
Johns Hopkins University	Investigation of the mechanism of bone deposition and related physiological studies.	4,980	22,000	22,000
Do	Enzymatic histochemistry of the ocular lens.	2,044	3,888	4,000
Kansas, University of	Cytochemical, microchemical and biophysical studies of tumors and effects of radiation upon cells.	30,744	39,420	30,000
Kresge Eye Institute	Effects of neutrons and other radiations on the ocular lens.	4,000	15,500	16,213
Louisiana State University	Studies of liver physiology and pathology, involving the use of bromsulphthalein containing S_{35}.	3,712	1,300	0
Lovelace Foundation	Indirect blast injuries	0	50,000	90,000
Maryland, University of	Studies on monkeys following exposure to large doses of total body irraditation.	10,787	14,963	16,500
Massachusetts General Hospital	The use of thermal and epithermal neutrons in the treatment of neoplasms.	18,275	19,151	18,725
Do	Establishment of a beryllium case registry.	0	13,000	13,000
Do	Effects of radioactive iodine on biology of thyroid gland.	20,204	0	0
Do	A biochemical study of the effects of radiation on cells.	0	53,500	50,000
Do	The use of phosphorus $_{32}$ for the precise localization of brain tumors.	11,880	11,880	12,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Massachusetts Memorial Hospital.	Physiological and therapeutic investigations and fundamental blood studies using radioactive isotopes.	$8,408	$22,986	$22,000
Do	Effects of radiation on the structure and function on the digestive system, particularly the gastro-intestinal tract in man.	6,300	20,250	20,000
Michigan, University of	Universal serologic reaction following irradiation. Investigation of the changes in the universal serologic reaction resulting from irradiation of human beings and animals.	23,707	24,700	0
Do	Biological effect of irradiation	107,903	126,358	140,000
Do	Survey of public reaction to atomic energy.	30,000	0	0
Minnesota, University of	The influence of radiation and chemically induced bone marrow injury upon porphyrin metabolism.	13,950	18,680	20,000
Do	Effect of ionizing radiations on electrolyte and water metabolism.	5,913	45,199	46,000
Do	Synthesis of hemoglobin in bone marrow and maturation and multiplication of blood cells; studies in chemical hematology.	20,286	25,578	26,000
Montefiore Hospital for Chronic Diseases.	The relationship of stable and radioactive lanthanum to nucleic acid synthesis in normal and neoplastic tissue.	12,179	15,372	10,000
Mount Sinai Hospital	The use of isotopes in the study of the etiology of drug eruptions.	3,104	0	0
National Academy of Sciences	Support of committee on radiation cataract studies.	4,824	8,000	8,000
Do	Support of subcommittee on blood derivatives and shock.	0	5,000	5,000
Do	Maintenance of medical sciences information exchange.	20,000	20,000	20,000
New England Deaconess Hospital.	Acute and chronic radiation injury	99,543	95,757	150,000
New York Medical College	Study of vascular factors in radiation hemorrhage and other hemorrhagic diatheses in patients and experimental animals.	19,372	11,835	13,955
New York University	Skin changes produced by low-voltage Roentgen ray irradiation.	4,400	0	0
Do	Influence of particle size in the retention of mist particles in the human respiratory system.	20,736	18,000	18,000
Do	I. The effect of refrigeration of human and animal skin upon its use in skin grafts following thermal injury. II. A study of antibodies produced by homologous skin grafts in animals and in man.	0	30,527	23,000
Do	Sodium and potassium distribution in man.	6,962	7,000	7,000
Do	Investigation of the physiology and biochemistry of nuclei and nucleic acid.	17,766	16,583	0
Do	The influence of ionizing radiation on enzyme systems.	6,264	6,000	6,000
North Carolina, University of	Effect of C-14 on the course of certain organic reactions.	3,367	5,367	0
Do	Radioautographic study of distribution and retention of beryllium in the rat.	20,581	12,545	13,000
Do	Tracer studies and irradiation in dental metabolism.	3,301	3,941	4,000
Northwestern University	The diagnostic and therapeutic use of radioisotopes in experimental medicine.	9,496	10,000	16,516
Do	Studies on radiation cataract	19,529	15,860	20,000
Do	Further development and utilization of radioactive dyes in the diagnosis and localization of brain tumors.	0	3,240	4,000
Notre Dame, University of	Comparative study of the biological effects of ionizing radiation in the normal and germ-free animal.	51,451	30,000	30,000
Office of the Surgeon General (Department of the Army).	Therapy of acute radiation syndrome and medical effects of A-bomb.	18,558	0	0
Oklahoma Research Institute	Isolation and identification of flavanoid pigments of possible use in the control of radiation injury.	13,250	9,250	10,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Oregon, University of, Medical School.	The studies on the metabolism of cholesterol and ketone bodies.	$19,262	$21,000	$21,000
Do	The effects of adrenocortical hormones upon the cultivation and transplantation of human blood cellular elements, and follow-up studies of radiation therapy patients.	0	13,000	14,000
Oregon, University of	Response of cells to deep radiation	661	0	0
Peter Bent Brigham Hospital	Intracellular changes in trauma, depletion and repair; biochemical studies in the human being with the aid of isotopes.	34,453	27,000	27,261
Philadelphia General Hospital	The effect of X-ray radiation on the infrared spectra of neural and radiosensitive visceral tissue.	0	15,765	16,000
Pittsburgh, University of	The effects of radiation on the virus-host cell relationship.	0	15,000	20,000
Do	Effects of neutrons from a cyclotron on mammals with particular reference to the development of cataracts.	9,165	14,000	15,058
Do	The study of the effects of radiation on the immune response with special reference to factors which increase the radioresistance of the immune response.	0	15,000	15,000
Do	Mechanism of protection against radiation.	5,863	8,548	9,000
Presbyterian Hospital	The mechanism of CO_2 fixation	1,500	5,500	6,500
Reed College (pt. I)	The application of the radioactive tracer technique in the field of cellular metabolism.	6,000	8,058	8,000
Reed College (pt. II)	The biochemical synthesis of peptide bonds.	7,500	9,674	10,000
Reed College	The effect of ionizing radiation on simple compounds.	0	16,500	13,500
Do	General training and research program	4,650	0	0
Rochester, University of	Use of plasma in shock effect	6,391	15,000	0
St. Louis University	Study of the relation of rickettsial and viral infections to radiation injury.	4,700	16,900	15,000
Saranac Laboratory of the Trudeau Foundation.	Clinical effect of Cortisone on chronic pulmonary granulomatosis.	2,000	2,000	200
Do	(1) Biochemical aspects of pulmonary disease in beryllium workers. (2) Clinical and experimental investigations concerning the biological hazards of beryllium.	59,105	46,070	40,000
Sloan Kettering Institute	(1) Biological effects of radiation, and related biochemical and physical studies. (2) Physiological effects of irradiation in patients receiving large doses of iodine-131 (3) Measurement on effects of irradiation on bone and bone phosphatase activity.	256,539	175,501	190,000
Syracuse University	Body defenses against hemorrhage in health and disease.	2,097	0	0
Temple University	Investigation of the breakdown products of para-aminobenzoic acid after radiation with X-rays.	0	5,000	5,000
Tennessee, University of	I. Absorption and intermediary metabolism of calcium. II. Effect of various aminoacids on the susceptibility of mice to infection with influenza virus. III. Thyroid metabolism IV. Mechanisms of ionic imbalance and athophysiologic states. V. Study of the effect of radioactive iodine on patients with carcinoma of the thyroid and with hyperplastic thyroids. VI. Study of the use of radioactive ruthenium in the treatment of superficial lesions. VII. The origin and fate of thiocyonate ion in metabolism.	36,082	30,607	26,291
Tufts College	Study of the relation of radiation on reactions associated with growth.	8,489	15,000	15,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Tulane University of Louisiana	Turn-over rates of chlorine and rubidium under controlled dietary and therapeutic conditions in patients with chronic congestive heart failure and in control subjects.	$2,100	$8,590	$8,000
Do	The influence of radiation injury upon physiology of serum lipids with particular reference to the function of the liver.	4,779	8,779	8,000
Tulane University School of Medicine of Louisiana.	The metabolic exchange of tissue electrolytes.	0	28,184	18,000
Utah, University of	Metabolism of trace elements in animals and man with special reference to their role in erythropoiesis.	2,700	8,100	9,000
Utah, University of, Medical School.	The effects of ionizing radiation upon electrolyte and water balance, blood volume, and nitrogen metabolism in dogs. Studies of the therapy of acute radiation injury.	0	21,000	20,000
Vanderbilt University	Study of the absorption and metabolism of lipids and the alterations which occur in acute radiation injury.	25,000	20,000	20,000
Virginia, University of, Medical School.	The metabolic exchange of radioactive phosphorus and potassium in isolated cell systems.	21,430	8,158	9,000
Virginia, University of	Effects of ionizing irradiation on mammals.	61,610	11,610	9,000
Wake Forest College, Bowman-Gray School of Medicine.	I. Distribution and turn-over of sodium and potassium in acute infections. II. Formation of tissue phospholipides. III. Toxicity of radiation as related to previous damage and the functional capacity of an organ; the effect of P-32 and X-rays on liver and marrow.	47,367	29,377	30,272
Washington University	Synthesis of nucleotides and related compounds.	12,667	20,845	20,000
Do	Effects of X-ray and nitrogen mustards on the immunologic response of experimental animals.	12,455	12,830	10,000
Do	Electrolyte balance and thyroid metabolism, absorption and distribution and thyroid physiology in humans with the aid of radioactive isotopes.	0	3,645	0
Washington, University of	Isotopes study in iron metabolism	17,800	18,000	18,000
Do	Synthesis of carbon-14-labeled diethylstilbestrol and a study of its metabolism in the body.	18,000	9,000	6,000
Do	Studies on endocrine and other factors governing the incorporation of labeled aminoacids into tissue proteins in vivo.	22,141	15,500	12,000
Do	Studies related to blood preservation	12,528	7,000	7,000
Do	Mobilization of radioactive emitters from bone.	9,288	7,000	7,288
Western Reserve University	Investigations of the biolofical effects of the internally deposited radioisotopes and related radiobiologic studies.	241,878	200,542	216,000
Do	Physiological and pathological aspects of thermal and flash burns.	31,739	32,000	32,000
Do	Effect of incorporated radioactivity on the biological activity of bacteriophage.	8,100	8,250	9,000
Do	Intermediary metabolism of carbohydrates by bacteria.	52,166	34,804	35,000
Do	The effects of ionizing radiation on the content and metabolic functions of ergothionine in hemaepoietic tissue.	4,730	7,560	8,000
Wisconsin, University of	Labeled aze dye research	72	0	0
Worcester Foundation	Investigation of the effects of radiation on the biosynthesis and metabolism of adrenocortical steroids.	23,387	51,904	61,000
Yale University	Metabolism of steroids and phenathrenes.	1,055	0	0

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Yale University School of Medicine.	I. Studies of factors influencing tissue sensitivity to radiation. II. Studies of oxidation and reduction factors in relation to radiation cataract.	$13,392	$14,000	$14,000
	Unallocated for renewals, extensions, or new projects.	0	137,803	266,238
	Total off-site university research program (medicine).	2,503,877	2,800,000	2,890,000

Biological research category

Biological research:

1951 actual	$8,771,891
1952 estimate	10,060,100
1953 estimate	10,344,000

SUMMARY

General statement

The biological research program of the Commission has two broad objectives. First, the prosecution of research on the biological effects of atomic energy and its products on the various forms of animal and plant life. An understanding of these effects is essential to the development of adequate protection against harmful quantities of radiation. Secondly, the exploitation of the unique tools afforded by radiation for the study of fundamental life processes and the development of new applications of atomic energy beneficial to society. The two objectives are inseparable in that the first depends upon advances in fundamental biological knowledge.

Biological research is carried out in the national laboratories and other major Commission facilities. In addition, a strong program of research is supported in many universities and private institutions. The general outline of the research problems and the approach to their solution follows:

Physiological and pathological effects of radiation.—A major aim of the biological research program is the better understanding of the mechanism and possible alleviation of the physiological and pathological effects of ionizing radiations. This is one of our major fields of endeavor and below are listed its more important phases.

(*a*) *Whole body irradiations.*—It is known that the lethal effects of whole body radiation are reduced by lowered oxygen concentration at the time of radiation, and that certain antioxidants such as cysteine, hormones such as thyroxin, and exercise and fatigue influence the lethal effects of radiation. Screening of numerous compounds of biological interest has been initiated with bacteria as the test organism. These compounds showing effects on bacterial survival to radiation are further tested upon animals. Investigations of effects of shielding particular organs or, conversely, of radiation of particular organs are under way. Further studies of this nature may lead to a general principle for alleviating radiation damage. Studies on the effects of radiation on enzyme systems will be continued since there is evidence that interference with the activity of cellular enzymes may be one of the chief mechanisms whereby radiation causes death.

(*b*) *Internal emitters and fission products.*—Both the manufacture of fissionable materials and the explosion of an atomic bomb may result in discharge of radioactive particles into the air where they may be taken into the lungs. Intelligent determination of permissible doses for internal radition requires continued investigation of the rates of absorption and elimination of such particles and of their toxicity. Studies of certain fission products, of radium, and of plutonium will be continued along with investigations of carbon 14 and tritium oxticity. In addition to the physiological effects, the genetic effects of internal radiation are under investigation.

(*c*) *Neutron toxicity.*—In view of the expanded production program, the experimental breeder reactor and other programs, all involving production of huge amounts of neutrons, studies of neutron toxicity will be continued at the accelerated level. Portions of the program on the biological effects of fast and slow neutrons are being conducted at the Argonne, Brookhaven, and Oak Ridge National Laboratories.

(*d*) *Stress and longevity effects.*—While considerable data is being accumulated on the lethal effects of both acute and chronic irradiation, there is little data on effects of radiation upon longevity and the work capacity. The effects upon the life span of sublethal doses of radiation are being studied quantitatively in mice, dogs, and burros. Similarly the work capacity of the exposed individuals is being measured. Accurate data on these problems are essential for certain military operations and are of vital basic concern.

Genetics.—The mechanism by which ionizing radiation produces changes in the cells and genes is being investigated. The relation of oxygen concentration to radiation-induced genetic changes and the reversal of ultraviolet effects by visible light are two possible approaches to the problem being followed at the Oak Ridge National Laboratory. The cytogenetic effects of fast and thermal neutrons are being studied intensively and methods for using biological organisms to measure neutron flux have been developed. The cytogenetic and genetic effects of chronic low level radiations are under study in a variety of organisms, including bacteria, protozoa, plants, and higher animals. Studies of the rate of induction and the accumulation of mutations are being conducted in experimental populations of fruitflies (Drosophila) exposed to acute and chronic gamma radiation. A large-scale test of radiation-induced mutation rates in mice has given data valuable for a more accurate estimate of the human genetic risks of applications of atomic energy. This study will be continued and extended. Studies of spontaneous human mutation rates have been initiated. The exploiting of the unique tools afforded by atomic energy not only advances fundamental genetic knowledge but at the same time supplies data necessary for estimating the genetic consequences of atomic energy.

Ecological and aquatic biology studies.—Since dilution, either in air or water, is one of the major methods of disposal of radioactive waste materials, it is necessary that the effects of such material upon plant and animal life of the surrounding area be determined. The effect of stack discharge of radioactive materials is being studied. The major stack-gas problem occurs at the Hanford plant where it is being studied by the biology division of the Hanford plant and the applied fisheries laboratory of the University of Washington. The concentration of radioactive materials by algae and other forms occurring in the Columbia River is under investigation The biological chains by which such radioactive materials are transferred to fish that may be used for human consumption will be traced. The lethal and genetic effects of radiation upon fish and other marine forms also are being studied at these installations. Small-scale ecological surveys designed to supplement the Hanford studies will be undertaken at the reactor test station and Savannah River sites.

Agronomics.—The function of minerals and the mechanisms by which they are used by growing plants are being investigated by means of radioisotopes. These studies are pertinent to RW warfare and defense against it. Investigation of the utilization of C^{14} and tritium by plants elucidates both toxicity problems and contributes to knowledge in plant biochemistry. Research on radioactive fertilizers may lead to increased crop production. At the same time the AEC is concerned by the fact that the radioactive mineral strontium is the major long-lived fission product from atomic explosions, and it is taken up and concentrated by plants 100 to 1,000 times more than any other fission product. The carbon isotope (C^{14}) is a major tool for the study of the photosynthesis process which utilizes the sun's energy generated by atomic reactions. The control and exploitation of the process of photosynthesis promises to be one of the major scientific achievements of the future. Already some of the knowledge gained by these studies is being utilized in the biosynthesis of drugs and other compounds beneficial to mankind. It is possible that in the future the process will be the major source of industrial organic compounds which today are oil and coal.

Research contract program.—In addition to the research carried on at AEC laboratories, the Division of Biology and Medicine administers a growing series of biological researches by direct contracts with universities throughout the United States. In general these contracts cover a broader field, but they involve both programatic and general or basic studies. The first group is usually initiated by the Division because of the need of specific answers for certain practical problems associated with the production and utilization of atomic energy. The second group is ordinarily suggested by the universities and is commonly concerned with certain broad fields of biological research for which radiation and radioisotopes are essential tools. Each of these types involves fundamental scientific research in which the methods and standards are essentially the same. These contracts are negotiated so that the university bears, on the average, about one-half of the

cost of the research and acquires a more direct interest in the successful outcome of the studies. Since younger scientists are usually associated with the contracts as research assistants or technicians, a continually growing group of competent people is being trained in the techniques of radiation biology. The contracts listed in this section are widely dispersed throughout the country to strengthen as many centers of research as possible. Thus through this program, the Commission utilizes the scientific talents and facilities of the universities, and at the same time discharges its responsibility to foster research and to promote education and training in this relatively new field.

Activity and location	1951 actual	1952 estimate	1953 estimate
B-1 Argonne National Laboratory	$2,043,866	$2,205,000	$2,255,000
B-2 Brookhaven National Laboratory	776,190	960,000	983,000
B-3 Hanford area	655,430	675,000	725,000
B-4 Oak Ridge National Laboratory	1,397,439	1,495,000	1,525,000
B-5 University of California at Berkeley	1,019,203	1,345,000	1,373,000
B-6 University of California, Los Alamos	666,523	660,000	700,000
B-7 University of California at Los Angeles	448,716	540,100	548,000
B-8 University of Tennessee	190,071	190,000	175,000
B-9 University of Washington	75,464	90,000	80,000
B-10 Off-Site University research program (biology)	1,498,989	1,900,000	1,980,000
Total, biological research accrued cost basis	8,771,891	10,060,100	10,344,000

DETAILS

	1951 actual	1952 estimate	1953 estimate
B-1 Argonne National Laboratory	$2,043,866	$2,205,000	$2,255,000
Man-years (scientific only)	61	67	67
See classified section for details, pp. 428–432.			
B-2 Brookhaven National Laboratory	$776,190	$960,000	$983,000
Man-years (scientific only)	19	33	41

The biology research program at Brookhaven is centered around the effects of radiation on plants and animals. The special facilities of the pile will be utilized to investigate the effects of both slow and fast neutrons. The effect of gamma radiation on the growth and genetic behavior of plants of economic importance is being investigated. The possibility of utilizing gamma radiation to develop new strains of plants of special economic value will be studied. The effects of neutron radiation and X-ray radiation on growth, rate of mutation and synthesis of nucleoproteins are being investigated using lower organisms such as bacteria. The effects of neutron and X-ray radiation on electrolyte balance and on endocrine function are being studied in mammalia.

(1) *Genetics $368,000.*—The genetic program involves the cytochemical and physiological effects of neutrons and ionizing radiations on plants of economic import and on lower forms of organisms. The effects of internal radiation and neutron radiation on biochemical processes, the chemical, physical, and biological factors influencing radiation damage will be investigated.

(2) *Iodine generator, $145,000.*—A new type safe, portable generator to make 2.4 hr I–132 available for medical and biological use has been completed by the laboratory. The short-life iodine will be used in diagnostic and chemical work, and production and delivery to the BNL Hospital will continue through fiscal year 1953, and extended to the preparation of additional isotopes.

(3) *Mineral accumulation, $46,000.*—The biology and chemistry of mineral accumulation in plants and animals involve a study of plant species in an effort to find plants that selectively absorb and concentrate heavy minerals and especially those of major interest to the Commission. This is of importance from both the standpoint of waste disposal and indicator plants for various elements.

(4) *Intermediary metabolism, $180,000.*—Plants and animals are being investigated using various radioisotopes and the effects of radiation on metabolic processes. This includes work with iron, phosphorus and carbon–14 in both plants and animals; the synthesis of labeled compounds, and metabolism of the penteses, hexoses, and nucleic acids.

(5) *Physiological effects of radiation, $64,000.*—This project is designed to study the effects of ionizing and neutron radiation on mammalia; rate of recovery of

fasted and fed animals and the effects of radiation on tissue constituents. Anorexia is a common symptom of radiation injury. A new technique has been devised to measure separately the direct effects of radiation and that of failure to consume food. The effect of radiations on proteins, enzymes, and other constituents will be studied. The effects of radiation on capillary circulation will be investigated. This has involved new techniques for measuring damage to the capillaries. Since hemorrhage is a common symptom of radiation injury, this is important in understanding the mechanism of radiation injury.

(6) *Neutron radiation, $180,000.*—The purpose of this study is to determine the biological effects of slow neutrons as measured by growth of various plant and animal species, the effect on biochemical mechanisms, enzyme systems and other physiological factors. This work will be expanded when the thermal neutron column is completed.

	1951 actual	1952 estimate	1953 estimate
B-3 Hanford area	$655,430	$675,000	$725,000
Man-years (scientific only)	40	43	44

The biology division at Hanford is responsible for assessing the extent of biological damage which can be caused by various radioactive materials produced at Hanford works, and to study means for prevention or revearsal of the damaging effects. Information obtained here is being applied at other installations as, for example, the Columbia River survey applied to the Savannah River. The research program is divided into six groups as described below:

(1) *Analyses group, $44,000.*—(*a*) To measure amounts to radioactivity, i. e., tritium, in biological specimens submitted by other groups, (*b*) to perform radiobiochemical analyses as required for various research projects, and (*c*) to initially prepare and calibrate radioactive substances used by personnel of the biology division.

(2) *Aquatic biology group, $155,000.*—(*a*) To determine the effects of pile effluent water on commercially valuable fish, (*b*) to determine means and extent of transfer of pile effluent radioactivity from lower to higher aquatic life, and (*c*) to determine whether Hanford production plants are having any effect on the ecological balance between organisms of the Columbia River.

(3) *Biochemistry group, $42,000.*—(*a*) To provide services in blood and urine analysis to other groups in the biology division, (*b*) to determine permissible maximum concentrations of radioactive materials common to Hanford works, and (*c*) to make available therapeutical procedures for radioactive materials which may contaminate personnel.

(4) *Botany group, $108,000.*—(*a*) To determine metabolic characteristics of production radioisotopes in plants, (*b*) to assess the extent of damage to plants caused by the isotopes, (*c*) to determine the over-all effects on agriculturally important plants exposed to production effluents under controlled conditions, and (*d*) to find if growing plants can be used as monitors to detect underground movements of radioactive materials. The uptake of tritium water by plants is of special interest.

(5) *Physiology group, $96,000.*—(*a*) To provide other groups in the Division with services in tissue preparation, photomicroscopy, autoradiography, and assistance in physiology techniques, (*b*) to assess the hazardous radioactive particles emitted in production, and (*c*) to determine lower limits of toxicities of radioisotopes deposited on bone.

(6) *Zoology group, $280,000.*—(*a*) To routinely determine radioactive contamination present in land animals indigenous to this territory, and (*b*) to determine the results of exposing stock animals to selected radio elements of particular importance to Hanford Works.

	1951 actual	1952 estimate	1953 estimate
B-4 Oak Ridge National Laboratory	$1,397,439	$1,495,000	$1,525,000
Man-years (scientific only)	63	76	83

The biological-research program at the Oak Ridge National Laboratory will continue at approximately present level of operations for fiscal year 1953. The broad objectives of the programs are to fill the need for knowledge of the effects of

radiation on inheritance and on the chemistry of the living process of cells which are the fundamental units of all living organisms. The program is composed of the following major projects:

(1) Fundamental research on the biological effects of radiation, $451,000

(*a*) *Cytogenetic effects of radiations.*—This work is concerned with basic studies on the effects of radiation on chromosome breaks, mutations, and reverse mutations. Studies on the role of oxygen in cytological effects and research on cytogenetic effects of neutrons will be expanded. Beginning in the fiscal year 1952 studies will be expanded or initiated on the effects of radiations upon yeast and bacterial viruses, the relation of the gene to biochemical properties, biochemical genetics, and the mechanism of the effect of slow neutrons and alpha particles.

(*b*) *Effects of radiations on paramecium.*—Studies of ultraviolet effects and the photorecovery from such effects will be continued. Studies concerned with cytoplasmic inheritance employing X-rays, the analysis of inheritance of reduced vigor following radiation, and the delay in cell division following X–rays will be expanded during the year.

(*c*) *Radiation effects on mitosis and upon fungi.*—Studies of the effect of oxygen concentration upon the radiation-induced delay in cell division will be continued. The efficacy of chemicals discovered to partially protect bacteria against radiation will be tested on grasshopper neuroblasts. A combined radiation-metabolism study of fungi will be initiated in the hope of determining the specific metabolic process of cells which are affected by radiation.

(2) Radiation chemistry, radio-organic chemistry, and radiation biochemistry, $185,000

(*a*) *Radiation chemistry.*—Studies of the production of oxidizing radicals in aqueous media and solutions of biological interest will be continued. Radiochemical theories will be applied to biological data. The protective effect of certain compounds of biological interest will be tested in radiation-oxidation studies by simple organic molecules and results correlated with those from bacteria and other biological radiation-protection tests.

(*b*) *Radio-organic chemistry.*—A number of labeled amino acids will be synthesized for biological studies. As labeled compounds are required for other projects, they will be synthesized by this group.

(*c*) *Radiation biochemistry.*—Studies of cellular effects of radiation will be continued with emphasis upon electrolyte disturbances in red blood cells. In fiscal year 1953 studies of electrolyte balances on other cells, development of an acceptable theory concerning radiation effects upon pollen-cell germination, and attempts to improve techniques in radiation measurements, especially fast neutrons, will be initiated.

(3) Biochemistry and metabolism, $293,000

(*a*) *Biochemistry of nucleoproteins, amino acids, and enzymes.*—Studies of enzyme-substrate complex formation and the relationship of these to radiation sensitivity will be continued. Since the biological effects of radiation may result in part from changes in enzymes and in nucleoproteins, studies of various enzyme systems and nucleic acid synthesis will be continued.

(*b*) *Tracer studies on metabolism.*—C^{13} and C^{14} tracer studies on intermediary metabolism will be continued with selected microbial enzyme systems and animal tissues. This work will furnish the basis for projected studies of radiation effects on synthetic processes in living organisms. In fiscal year 1953, tritium will be used as a tracer in studies of hydrogen-transfer reactions and as a source of radiation in studying certain biological reactions.

(4) Radiation protection, $48,000

Screening of compounds for possible radiation-protection effects will be continued. The X-ray killing of bacteria has proven to be a convenient and economical primary screening method. Compounds showing protective effects are further tested upon other biological systems including mice. Studies will be expanded to include other radiations, including certain radioisotopes, and other mammals than mice.

(5) Plant physiology and photosynthesis, $109,000

(*a*) Studies on the plant biosynthesis of labeled sugars and sugar intermediates, organic acids, and nucleic acids will be continued along with the development of chemical procedures necessary to isolate and purify the labeled compounds. In fiscal year 1953 the methodology should be completely worked out and studies of certain problems in plant physiology will be initiated. These include studies of

the effects of different plant environments, effects of radiation on plant biosynthesis and growth, effects of various herbicides, and the synthesis of certain alkaloids, certain aromatic amino acids, and ascorbic acid.

(*b*) *Photosynthesis.*—In fiscal year 1951, it was discovered that green plants exposed to light continue to emit light for some 2 minutes after illumination and that this emission is related to the first steps in the photosynthetic process. Studies of the phenomenon will be continued and an automatic Warburg apparatus developed to permit simultaneous measurement of oxygen production and light emission, including spectrographic analysis of the emitted light.

(*6*) *Pathology and physiology, $204,000*

Studies of the long-term changes such as cancer induction and cataract formation following neutron and other radiation exposures and of the mechanisms of irradiation death, especially the anemia and hemorrhage problems, will be continued with the thought in mind of developing methods of control. In fiscal year 1952 and 1953, increased emphasis will be placed upon sublethal exposures to pile radiations, C^{14} and tritium radiations, with especial consideration to tumor and cataract incidence and effects upon longevity.

(*7*) *Mouse radiation genetics, $235,000*

The first reliable estimate of X-ray induced mammalian mutation rates were obtained during fiscal year 1951. This work will be continued and expanded in fiscal year 1952 and 1953, and will yield data of great importance in the reevaluation of human genetic hazards associated with atomic energy. Studies of high- and low-level radiation doses on embryological development will be continued. In fiscal year 1953, other radiations, lower dosage levels, the effectiveness of anoxia in preventing X-ray induced mutations will be studied. Developmental effects will be investigated in fiscal year 1953 at lower dosage levels, at later periods than birth of the embryos, and following neutron exposure.

	1951 actual	1952 estimate	1953 estimate
B–5 University of California (Berkeley)	$1,019,203	$1,345,000	$1,373,000
Man-years (scientific only)	46	58	60

This laboratory's biological program covers problems on body functions and the biological effects of radiation. Particular emphasis is placed on chemical, physical, and tracer techniques and building up a broad understanding of physiological and biochemical processes. The program may be considered under the following headings:

(1) *Physical biochemistry, $197,000.*—This is a continuing program on the separation and purification of large molecules such as proteins and lipoproteins and the study of the rates of formation of these molecules in normal and irradiated animals. This has led to the better understanding of abnormalities in fat metabolism, to studies on arteriosclerosis, and to investigations of large molecule lipoprotein formation in relation to lethal radiation effects.

(2) *Radiobiology, $228,000.*—The work is divided into two major parts, (*a*) radiation studies with the accelerators, especially the 184-inch cyclotron, and (*b*) metabolic studies. As an example of new research in fiscal year 1953 with the accelerators, the biochemical effects of very heavy cyclotron accelerated nuclear particles on biochemical materials will be studied. This is being done as programmatic work and can also be related to problems concerning cosmic radiation. Biochemical changes in irradiated tissues and animals is a continuing program on the investigations involving nucleic acid metabolism. This is being studied as indicative of cell division. Biochemical and physiological results of localized radiation of individual organs of the body and deep seated tumor tissue will be studied and compared with the mechanism of action of other types of irradiation on the body. A new project on radiation chemistry of dilute organic solutions will be initiated.

(3) *Tracer biochemistry, $380,000.*—The biochemistry of fission products and fissionable materials are significant in relation to health hazards and protection in the atomic energy field. The fate of radioactive tantalum dusts and other fission products when brought into the body is a continuing project. The use of chelating agents for removing certain fission products from the body of man is being investigated. A new project to be initiated will deal with the oral ingestion of fission products in aqueous solutions.

(4) *Bio-organic chemistry, $398,000.*—This group of projects deals specifically with radioactive carbon, C14. C14 is employed in the synthesis of various organic compounds which are then used in (1) biochemical studies in animals and men throughout the rest of the program, and (2) in studies of the mechanism of organic reactions, and (3) in studies on physical chemical phenomena. Also included in this program is considerable work on intermediary metabolism studies using the C–14 labeled organic compounds for tracer studies.

(5) *Animal colony and quantitative measurement of radiation, $170,000.*—The animal colony now under construction will be fully utilized in fiscal year 1953 for the whole program.

	1951 actual	1952 estimate	1953 estimate
B–6 University of California, Los Alamos	$666,523	$660,000	$700,000
Man-years (scientific only)	26	30	33
See classified section for details, pp. 433–435.			
B–7 University of California, Los Angeles	448,716	540,100	548,000
Man-years (scientific only)	54	54	54

The biology research program of the University of California at Los Angeles is organized into three divisions. In fiscal year 1953 the research programs of these divisions will be continued along the same lines of investigation and at about the same level operation as in fiscal year 1952.

(1) *Biochemistry studies.*—The metabolism of fats and fatty acids and the effects of radiation on the intestinal absorption of fats, proteins, and carbohydrates are under investigation. Various isotope-labeled substrates and organic compounds of biological interest employed in the above studies are synthesized by the laboratory. This is the only AEC laboratory investigating this problem and the scope and direction of these projects will be the same in fiscal year 1953 as in fiscal year 1952. Radiation effects on various enzyme-substrate systems are also being studied such as the hyaluronidase-hyaluronic acid system associated with capillary permeability, fertilization, and mobility of joints.

(2) *Radiobiological work.*—Research is directed toward an understanding of the mechanism whereby radiation effects are produced. The direct and indirect effects of radiation are being studied. Toxic factors produced by radiation and methods of enhancing or decreasing the biological effects of radiation are under investigation. A quantitative method of detecting small biological effects from low level radiation exposure is being developed. Studies of proton effects will be initiated in fiscal year 1953. Studies of an antibiotic influencing the bacteremia of the radiation syndrome will be vigorously pursued in fiscal year 1952 and fiscal year 1953. In addition to intensive research in radiation biology, the division participates in a training program in radiation biology at the graduate, undergraduate, and technical levels.

(3) *Industrial hygiene.*—This primarily service division is responsible for maintenance of instruments and personnel and area monitoring. The research of the division is concerned with development of improved radiation detection and monitoring instruments, air pollution studies, and development of spectrographic methods for detecting and measuring minute amounts of various materials in body and plant tissues.

	1951 actual	1952 estimate	1953 estimate
B–8 University of Tennessee	$190,071	$190,000	$175,000
Man-years (scientific only)	8	8	8

The effects of radiation and radioactive isotopes upon the reproductive efficiency of various farm animals and the metabolism of minerals are major projects which will continue. Studies of fission product metabolism will be continued, including the effects of certain fission products upon the fertility and health of large animals and the accumulation and retention of fission products in the tissues, bones and milk. Fission products to be studied include proactinium, yttrium, lanthanum, tantalum and strontium.

	1951 actual	1952 estimate	1953 estimate
B-9 University of Washington	$75,464	$90,000	$80,000
Man-years (scientific only)	7	8	8

The effects of chronic and acute radiation upon trout and salmon eggs and embryos and the accumulation of radioactivity in the tissues of fish samples from the Columbia River are being determined at the applied fisheries laboratory. Genetic studies of irradiated salmon and trout will be redirected with the objective of obtaining quantitative genetic data as well as certain cytological data. Problems associated with the cooling water and studies of the relation of temperature of the river water to ecological changes will be initiated in fiscal year 1952 and continued in fiscal year 1953.

	1951 actual	1952 estimate	1953 estimate
B-10 Off-site university research program (biology)	$1,498,989	$1,900,000	$1,980,000

In accordance with its responsibility to foster private research, as required by the Atomic Energy Act, to conduct an educational program in the relatively little known field of radiation biology, and to make available to the atomic-energy program the facilities and services of the Nation's outstanding institutions and scientists, the Commission has supported biological research in universities throughout the country. It is anticipated that the support of biological research in universities will continue to increase as additional investigators become trained in radiobiology.

The estimated costs for the activity by separate projects are listed below:

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Amherst College	Research in radiobiology and chemical genetics.	$9,144	$22,000	$22,000
Arizona, University of	Utilization of phosphorus from biological material.	1,989	3,351	3,000
Arkansas, University of	Investigation of intermediary metabolism of the photosynthetic bacteria.	7,400	7,500	7,500
Do	Studies on the biochemical and nutritional aspects of X-radiation injury.	0	10,300	11,000
Do	Basic studies in the use of cobalt 60 as radium substitute.	4,400	4,500	4,500
Battelle Memorial Institute	Study of mode of action of fungicides	12,804	13,000	14,471
Boyce Thompson Institute	Use of tracer fungicides in determining the mechanics of protecting plants from fungous diseases.	16,761	12,950	11,000
Brooklyn Polytechnic Institute	Factors influencing the solubility of heavy-metal complexes and their metabolism.	3,780	5,130	6,000
Do	Effect of ultraviolet radiation on enzymes and viruses.	7,210	5,500	5,500
Brown University	The role of intestinal flora in radiation injury.	12,936	18,872	21,000
California Institute of Technology.	Biological synthesis of protein with use of isotopes.	29,982	65,007	25,000
Do	The genetic and cytological effects of high-energy radiation.	124,854	75,000	75,000
California, University of	The sites and mechanisms of action of physiologically active substances with particular application to drugs acting upon the autonomic nervous system.	16,191	11,804	9,804
Do	Intermediary metabolism of organic compounds and biological synthesis in farm animals.	12,985	25,485	51,310
California, University of (Citrus Experimental Station).	Use of radioactive tracers in studies of the mode of action of organic insecticides.	2,130	4,500	7,500
California, University of	Study of plant viruses	0	13,064	13,000
Do	Chemical activities of plants and bacteria; tracer studies of the metabolism of subcellular particles.	12,000	15,157	22,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
California, University of—Con...	The effect of radiation on work capacity and longevity of the dog.	0	$51,956	$80,000
Do	The internal and external factors affecting ion absorption by plants.	$5,802	7,776	8,000
Do	The translocation of herbicides in plants; the use of radioactive isotopes and other indications to study absorption and distribution of herbicidal chemicals.	0	9,475	9,500
Chicago, University of	Biosynthesis of radioactive drug compounds.	50,000	30,000	27,500
Do	Purchase and installation of Van De Graaf generator.	98,107	21,893	0
Columbia University	The metabolism of ascorbic acid and glucose labeled with C14 in known positions.	0	9,565	10,500
Do	The population genetics of species of drosophila.	0	6,000	6,000
Connecticut Agricultural Experimental station.	Therapy of plant disease by nuclear radiations.	1,675	8,500	10,000
Delaware, University of	Comparison of effects of X-rays, neutrons and mustard compounds on the growth and development of the corn seedling.	2,933	0	0
Do	Radiation effects upon haploids and diploids of habrobracon.	4,521	4,968	4,968
Department of Agriculture	Production and use of radioactive labeled fertilizers and the effects of internal radiation on plant growth.	173,639	214,182	185,000
Do	The effects of radiation on chickens with special reference to egg production, fertility, and other physiological factors.	12,668	29,648	30,000
Do	Embryonic metabolism and internal radiations.	30,680	25,500	30,000
Department of Interior	Working agreement: Study of cold-water fish. The accumulation of radioactivity in salt-water fish.	50,975	25,000	25,000
Duke University	Study of factors affecting the absorption of radioactive phosphorus by mycorbizal and nonmycorbizal roots of pine.	2,970	5,878	6,000
Do	(a) Isolation and properties of rat-liver nuclei; (b) shell formation in mollusks and barnacles as studied by radioisotopes.	18,439	18,143	8,000
Emory W. Thurston Laboratory	Comparative effects of the known B vitamins and an unidentified antitoxic factor in liver on radiation injury in the rat.	1,500	6,000	6,000
Florida, University of	Concentration of mineral elements in the fetus and the relationship to placental transfer of these elements.	0	16,740	17,000
Fordham University	Fate of thiamin analogs in the animal body, mechanism of thiamin inhibition by thiamin analogs.	2,625	5,400	5,400
Do	Enzymatic degradation of native and chemically modified proteins.	25,438	13,553	10,000
Georgia, University of	The production of mutant strains euglenoid flagellates and their use in the study of carbon dioxide fixation processes.	6,759	0	0
Do	An ecological study of land-use, succession and indicator invertebrate and warm-blooded vertebrate populations of the Savannah River operations area.	0	10,000	10,000
Harris Research Laboratories	The chemistry of biosynthesized isotopically labeled cellulose and allied polysaccarides.	15,400	13,390	13,000
Harvard University	Intensity of radiation and chromosome breakage.	5,756	290	0
Howard University	The effect of labeling the germ cells on fertilization and development.	4,076	4,500	4,500
Idaho, University of	A study of absorption and translocation of mineral elements in diseased and healthy western white pine by the use of radioactive materials.	0	18,000	12,628

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Illinois, University of	Intermediary metabolism of carbohydrates.	0	$10,000	$7,000
Do	Nutritional biochemistry and metabolism of amino acids and vitamins.	$7,500	6,200	6,200
Do	Content in human tissues of 11 trace elements.	4,250	8,600	8,650
Indiana, University of	Specific immobilization sustances (antigens) of paramecium aurelia.	6,000	8,700	9,500
Do	The mechanism of the combination of antigen and antibody.	1,075	4,300	5,000
Do	Immunochemistry of paramecium aurelia.	0	6,804	7,000
Iowa State College	Metabolism and physiology of roots	8,425	12,299	12,000
Do	Combined biochemical and physiological action of tyrosine and vitamin B_{12}.	12,600	13,604	12,000
Do	Studies of metabolism of purine and pyrimidine bases of nucleic acids and nucleotides.	9,850	13,205	15,000
Do	Quantitative study of lifetime sickness and mortality and progeny effects from exposure of animals to penetrating irradiation.	28,740	150,165	150,000
Johns Hopkins University	Part played by the adrenals in the ability of rats to withstand radiation effects.	3,876	7,452	7,500
Do	Modification through the use of supplemental environmental factor of the frequency of gene and chromosome changes induced by X-rays, radioactive isotopes, ultraviolet light, and nitrogen mustard.	14,757	16,586	12,500
Do	Metabolism and functional significance of cobalt protein.	7,337	14,011	34,000
Do	Purification of intrinsic factor in gastric juice.	0	7,473	7,500
Kansas, University of	Radium chloride and hemopoietic physiology of rodents.	4,800	7,900	8,100
Long Island Biological Association.	Adaptive value of experimental populations exposed to radiations.	32,105	27,821	26,000
Louisiana State University	Investigations of the physiology, genetics and host-parasite relationships of plant pathogenic fungi by the use of radioisotopes for tagging fungus mycelium.	1,700	4,000	4,500
Louisiana State College	The effect of biotin on acetate, utilization and lipide synthesis by microorganisms.	1,399	3,000	3,000
Maryland, University of	The metabolism of acetate, B-hydroxybutric acid, glucose, and other carbon compounds in lactating ruminants.	10,000	10,000	10,000
Michigan Agricultural Experiment Station.	The absorption and utilization of radionuclides applied to leaves of plants.	2,349	10,557	9,500
Michigan State College	Transmethylation in plants	0	6,308	6,500
Do	Hormonal and nutritional factors which alter half lives and differential absorption ratios of calcium, manganese, and cobalt in the animal body.	20,791	16,780	9,000
Michigan, University of	Mutagenic effects of different types of radiation.	2,430	4,200	5,000
Do	The estimation of the rate of mutation of certain human genes.	0	24,060	24,000
Minnesota, University of	Effects of radioactive substances on plant pathogens and other microorganisms.	30,936	25,234	35,000
Do	Study of milk formation by the use of radioactive compounds.	6,480	8,000	8,152
Missouri, University of	Determination of thyroid activity in farm animals by the use of radioactive tracers.	7,020	7,020	7,500
Do	The genetic nature of induced mutations.	0	10,000	10,265
Do	Cytogenic study of the effects of radiation on the differential chromosomes of the tomato.	3,615	1,215	0
Do	Translocation of mineral substances in plants.	2,949	3,000	2,600
Naval Medical Research Institute.	Gamma ray generator	1,789	0	0

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Nebraska, University of	The genetic effects of thermal neutron irradiation of crop seeds.	0	$11,878	$13,000
North Carolina, University of	The effects of radiations of specific energies on mitosis.	$8,593	8,000	7,000
Do	The partial elimination of lethal genes before reproduction in drosophila by use of environmental agents.	4,263	7,264	7,000
Do	The genetic and developmental effects of ingested radioactives.	0	4,979	5,000
North Carolina State College	The effect of composition of the diet on lipide metabolism.	3,002	5,400	5,400
Do	Study of the movement of ions through soil systems.	8,654	10,525	10,933
Do	Effect of radiation on characteristics of peanuts.	34,035	16,965	13,550
Do	Investigation of the rate of movement of organic compounds in the tissues of intact tree species.	2,335	2,500	3,000
Oberlin College	Studies on the physiology of ion accumulation and electrolyte balance in living cells.	0	4,968	5,000
Ohio Agricultural Experiment Station.	The physiology and genetics of plant pathogenic micro-organisms when grown in the presence of various radioisotopes.	3,600	3,600	3,500
Oklahoma A. and M. College	Study of azotobacter mutants produced by beta irradiation.	2,490	2,376	0
Do	Isotope investigation of the mechanisms of nitrate reduction in bacteria.	0	3,715	3,715
Do	Effects of radiation on plant growth	4,752	7,830	5,000
Oklahoma Research Institute	Study of the effects of isotopic irradiation on embryonic capillaries.	1,922	5,994	4,000
Do	Study of the translocation of tagged 2,4-D and other growth regulators in plants in light and darkness.	5,788	6,797	6,000
Oregon, University of	Localization of radioactive isotopes in germ cells and reproductive tissues during quiescence and activation.	10,582	8,000	8,000
Oregon State College	Vitamin-amino acid and carbohydrate-amino acid interrelationship, using isotopic tracers.	8,845	10,787	12,000
Do	The mode of action of 2,4-D and isopropyl N-phenyl carbamate.	6,664	9,290	9,000
Pennsylvania, University of	Synthesis of isotopic carbon compounds used in biochemistry.	5,679	9,000	9,000
Pittsburgh, University of	Study of the correlation of radiation effects with physical and chemical changes in viruses.	12,900	12,000	12,000
Do	The study of normal and virus-infected living cells in tissue culture in perfusion chambers before, during, and after radiation.	0	12,258	12,500
Purdue University	Use of radioactive isotopes in studying mold metabolism.	3,976	4,800	5,800
Do	The physiology of hydrogen bacteria	2,052	4,200	4,200
Rice Institute	Action of relaxin and related studies in cellular metabolism.	26,855	9,695	8,700
Rutgers College	Distribution and accumulation of radioisotopes of physiological importance in shellfish.	4,001	4,200	4,200
Do	Histological and physiological effects of irradiation on tradescantia paludosa.	2,176	4,352	4,500
Smithsonian Institute	A biochemical investigation of photomorphogenesis in green plants.	6,400	9,600	9,500
South Carolina, University of	An ecological study of the land plants and cold-blooded vertebrates of the Savannah River.	0	10,000	10,000
South Dakota State College	Metabolism of selenium and sulfur in plants.	5,286	5,500	5,500
Southern California, University of.	Effect of radiation on intestinal absorption and metabolism of fats and carbohydrates.	26,063	28,674	26,000
Southern Illinois University	The effect of X-irradiation on a polyploid series of yeast cultures containing determined amounts of DNA.	0	9,800	8,500
Southern Research Institute	Study of dosages of C-14 labeled sodium formate required to produce radiation effects.	22,530	4,011	11,000

Institution	Project	Fiscal year 1951 actual	Fiscal year 1952 estimate	Fiscal year 1953 estimate
Stanford Research Institute	Study of the direct and indirect effects produced by X-irradiation of the spleen.	$5,162	$9,711	$11,627
Syracuse University	The study of intermediate carbohydrate metabolism in neurospora using radioactive carbon and biochemical mutants.	0	11,131	8,000
Tennessee, University of	Investigation of the influence of oxygen tension on the frequency of X-ray induced mutations and chromosome aberrations in drosophila.	4,221	0	0
Tennessee Agricultural & Industrial College.	Radiation and tracer element studies on certain pathogenic protozoa and nematodes of rodents.	3,219	6,456	6,800
Texas A. and M. College	Effects of X-ray irradiation on reproduction of the domestic fowl.	8,313	16,000	16,312
Do	Metabolism of glycerides	15,016	10,765	8,000
Texas, University of	Study of the relationships of algae to the disposal of radioactive wastes.	21,352	10,178	9,000
Do	Direct and indirect effects of radiations on genetic systems.	0	20,400	34,500
Do	Metabolic processes in molds and fungi.	4,968	8,868	7,000
Union College	Biological effects of high-voltage radiation.	22,696	16,408	0
Utah State Agricultural College	Use of radioisotopes in the study of reproduction.	3,000	4,615	5,000
Do	Use of radioiron in studying lime-induced chlorosis.	6,100	7,560	7,900
Utah, University of	Use of labeled phosphorus in the study of nerve tissue metabolism during invasion of neurotropic viruses.	6,411	8,944	9,000
Do	Studies of photosynthetic processes in cell-free preparations.	17,874	20,000	22,000
Washington, State College of	Absorption, translocation, and disposition of various elements in plants.	3,464	9,446	14,000
Do	Rate of movement of ions into and through parenchma tissue as affected by rate of water uptake.	3,400	3,542	3,800
Do	A study of factors influencing the biological effects of X-rays.	0	4,900	5,300
Do	The effects of X-rays upon the optical specificity of papain.	0	3,524	3,600
Do	The zinc nutrition of plants in calcareous soils.	0	7,992	8,000
Wisconsin, University of	Metabolism of organic acids in higher plant and micro-organisms.	6,555	6,750	7,000
Do	Biological nitrogen fixation with isotope tracers.	5,100	5,400	6,000
Do	Effect of radiation on enzymes in the cyclophor se system.	22,890	15,620	20,000
Do	Use of radioactive isotopes in determining the role of root grafting in forest trees.	6,555	7,000	10,149
Do	Long-time effects of intermittent radiation on dogs.	13,878	14,000	13,878
Do	Cytogenetic effects of radiations on bacteria.	0	1,080	5,000
Wyoming, University of	Investigations of the interrelationships of sulfur, phosphorus, and calcium in selenium metabolism.	8,309	7,850	8,000
Yale University	Irradiation of viruses and large molecules.	19,440	18,000	14,000
Do	Investigations on the mechanism of radiation-induced chromosomal rearrangements in tradescantia and gene mutations in neurospora.	39,906	13,000	13,000
Do	Relationship of genes to biochemical reactions in neurospora.	6,415	10,215	7,000
Unallocated for renewals, extensions, or new projects.		0	43,716	152,088
Total, off-site university research program (biology).		1,498,989	1,900,000	1,980,000

Biophysics research category

Biophysics:

1951 actual	$3,415,294
1952 estimate	4,087,500
1953 estimate	4,314,000

SUMMARY

General statement:

The biophysics research program is continuing along the following principal categories:

1. Determination of the permissible dose of radiation for humans, animals, and plants. Increased emphasis is being placed on the problems associated with protection from internal emitters.

Internal emitters are radioactive substances which may find entrance into the body (as by inhalation, ingestion, through open wounds, etc.) and hence irradiate organs internally. Some of these substances, such as radium, plutonium, strontium, have a tendency to become fixed in the skeleton, or others such as chromium may be absorbed and held in the liver over a period of time. Other radioisotopes may tend to concentrate in other tissues. Enough evidence is available that we know that serious harm can arise from the deposition of radioactive materials in the human body.

The exact determination of permissible levels of exposure to internal emitters is a difficult matter, primarily because of the extreme complication of the problem, the large number of contributing factors, and the paucity of available facts concerning the reactions of living organisms to radioactive elements. Most of the information which is available was obtained in short-time (acute) experiments with relatively large quantities of isotopes. Many of the factors relating acute effects to chronic effects are simply unknown.

2. The biophysics research programs in each of the national laboratories and production facilities emphasizes the study of radiation protection (health physics) problems, peculiar to that installation. Much of the effort of these in-plant programs is directed toward problems of instrumentation and development of methods and techniques for measuring radiation. Many of the maximum permissible dose figures, particularly for internal emitters, are quite low; for example, the maximum permissible dose for plutonium in air is 6 by 10^{-8} milligrams per cubic meter of air while the tolerance for seriously toxic (but not radioactive) substance such as chromic acid, lead, mercury, selenium, is 0.1 milligram per cubic meter of air, nearly 2 million times less stringent than for plutonium. Permissible levels of exposure to external radiation continue to be studied, particularly as regards beta radiation and neutrons; adequate instrumentation is under concomitant development.

3. The establishment of a continental test site has created some additional demand on the biophysics program, because it has been necessary to set up monitoring stations over the entire United States. Even though the radioactivity of the fall-out is below the health hazard level, it is measurable and has significance because of its effect on such industrial operations as the manufacture of photographic films. It is felt that within reasonable bounds the AEC must have data on the fall-out at selected spots throughout the continental United States.

The biophysics research program is beginning to level off and it is anticipated that by fiscal year 1954 the general level of operation will have been attained, unless new production operations develop new and different radiation protection problems.

	Activity and location	1951 actual	1952 estimate	1953 estimate
BP- 1	Arco site at Idaho	$11,774	$50,000	0
BP- 2	Argonne National Laboratory	354,100	229,000	$254,000
BP- 3	Brookhaven National Laboratory	118,127	125,000	153,000
BP- 4	Chicago area	9,580	16,000	16,000
BP- 5	Dayton area, Mound Laboratory	352,305	450,000	500,000
BP- 6	Hanford area	312,078	375,000	425,000
BP- 7	Oak Ridge area	157,610	112,000	75,000
BP- 8	Oak Ridge National Laboratory	496,912	653,000	563,000
BP- 9	Radiation instruments development	357,764	401,200	475,000
BP-10	Radiological Laboratory, NYOO	226,867	244,000	248,000
BP-11	Schenectady area (KAPL)	46,199	100,000	85,000
BP-12	University of California at Berkeley	73,857	75,000	84,000
BP-13	University of California at Los Angeles	126,287	107,300	110,000
BP-14	University of Rochester	0	150,000	156,000
BP-15	Off-site university research program (biophysics)	771,834	1,000,000	1,170,000
	Total, biophysics research accrued cost basis	3,415,294	4,087,500	4,314,000

DETAILS

	1951 actual	1952 estimate	1953 estimate
Specific programs:			
BP-1 Arco site at Idaho	$11,774	$50,000	0
BP-2 Argonne National Laboratory	354,100	229,000	$254,000
Man-years (scientific only)	7	6	7
See classified section for details, p. 436.			
BP-3 Brookhaven National Laboratory	118,127	125,000	153,000
Man-years (scientific only)	5	5	7

The program of this laboratory is directed into two general areas of investigation:

(1) *Radiation instrument development, $93,000.*—Special instrumentation is required for monitoring the neutrons and mesons which will be produced by the high-energy proton-synchrotron (cosmotron). Improved instruments are needed for monitoring gamma and neutron radiations in the neighborhood of the cyclotron. A chamber has been installed near the target of the cyclotron which works fairly satisfactorily but the associated circuit is makeshift. Similar improvements are needed at the Van de Graaff machine since those now being used are only temporary installations. One need is portable equipment that will permit crude energy spectrum determination to assist in the identification of radiations detected. Convenient monitoring of hot labs has been accomplished by the installation of modified Beckman MX–35 at the doors of the semihot labs, with lights to signify the sensitivity scale in use. A need exists for equipment useful over a wider range of particle sizes in air monitoring and for more sensitive continuous flow monitoring of liquid wastes.

(2) *Radiation dosimetry and measurement techniques $80,000.*—Design and testing of a Co^{60} howitzer and the development of plastic mounting sources for Co^{60} sources have been completed. Gamma radiations from Co^{60} are being studied in free space, near a ground plane and inside shielding enclosures. These basic studies in the design, construction and testing of ionization chambers for dosimetry work, are of particular significance to area monitoring and to users of Co^{60}. Studies are being initiated on neutron dosimetry methods as proposed by the subcommittee on neutrons and heavy particles of the National Committee on Radiation Protection. Tests have been conducted on the effectivenss of BNL sewage filter beds in removing specific radioactive contaminants. Development of methods of testing water and biological forms from the Peconic River for specific radioactive contaminants is planned.

	1951 actual	1952 estimate	1953 estimate
BP-4 Chicago area	$9,580	$16,000	$16,000

This item includes maintenance and calibration of emergency stockpile instruments located in the Chicago area, for use in the event of an emergency at Argonne or for use in case of an atomic bomb attack.

	1951 actual	1952 estimate	1953 estimate
BP-5 Dayton area, Mound Laboratory	$352,305	$450,000	$500,000
Man-years (scientific only)	18	22	24
See classified section for details, p. 437.			
BP-6 Hanford area	$312,078	$375,000	$425,000
Man-years (scientific only)	22	25	27
See classified section for details, pp. 438–439.			
BP-7 Oak Ridge area	$157,610	$112,000	$75,000

This program consists of two general activities. They are:

1. An ecological survey which began in 1951 to study the effects of the Oak Ridge pile and processing wastes on the living creatures and plants in the immediate vicinity. The major portion of this work is being done under contract with Tennessee Valley Authority, with Oak Ridge National Laboratory cooperating; $52,000.

2. Closely tied to the ecological survey is a meteorological study being done under contract with the United States Weather Bureau. The purpose of this study is to provide sufficient information on the meteorology of the area, so as to chart the course of the radioactive wastes discharged by the pile and "hot" chemical operations, $23,000.

	1951 actual	1952 estimate	1953 estimate
BP-8 Oak Ridge National Laboratory	$496,912	$653,000	$563,000
Man-years (scientific only)	32	35	35

It is anticipated that this program will continue at about the same level as 1951. The increase in 1952 reflects the inclusion of special instrument contracts subcontracted for by the laboratory, and dropped in 1953. The activities of the laboratory are quite varied, thus creating a wide variety of radiation protection problems. A broad breakdown of activity under this program is as follows:

(1) *Theoretical studies, $54,000.*—A mathematical, statistical and computation system has been provided for the Health Physics Division. Special computations such as the collision density of slow and fast neutrons in tissues are carried out; also theoretical studies of nuclear reactions, counting statistics, and determination of collision density of beams of thermal neutrons incident on slabs of tissue.

(2) *Special service problems, $33,000.*—A variety of short-range problems arise during routine operations and are handled by a separate group to prevent interruptions of long-range activities. These problems vary but include such as estimates of experimental shielding requirements, planning protective instrumentation needs for new facilities, and a review of surface tolerance deviations.

(3) *Radiochemical analysis, $20,000.*—A procedure has been developed for the radiochemical analysis of strontium, barium and rare earths in human urine; a procedure for quantitative separation of minute amounts of plutonium from large volumes of water containing silicates and other inorganic constituents is being sought. Chemical procedures for analysis of many long-lived fission products in connection with the ecological study are being developed.

(4) *Waste-disposal research, $181,000.*—The general purpose is fundamental and practical research and development; (*a*) to evaluate the potential hazards incidental to the release or escape of radioactive materials into the atmosphere or into surface or underground waters; (*b*) to define the factors that influence the extent and significance of such hazards; (*c*) to develop effective and economical measures for the prevention and control of hazards from radioactive waste. Laboratory and small pilot-plant studies on methods of water and liquid waste decontamination are continuing. A new technique for radio assay of fish tissue has been completed. Biological studies will continue to White Oak Creek (jointly with TVA).

(5) *Experimental radiation measurements and physics of nuclear radiation, $167,000.*—Studies are in progress on air activity dispersion, natural radioactivity and water supplies, and prospecting for uranium from the air. The investigation of film sensitivity for slow and fast neutron detection is partially finished. Absorption and back-scattering of beta particles by several materials are being studied.

(6) *Radiation dosimetry, $84,000.*—A new portable alpha survey meter results in a significant weight reduction, increased sensitivity and reliable operation in high humidity. Significant progress has been made in the study of fast neutron measurements around a reactor. Current programs are on neutron detection and dosimetry, beta dosimetry, and shielding with special reference to neutron dosimetry. A model of a beta-sensitive, pencil-type pocket ionization chamber is expected soon. A continuous radiation monitor for drinking water is well along in design.

(7) *Instrument development and stock pile maintenance, $24,000.*—Develops specifications and engineers prototypes of instruments suitable for production by industry, and for stockpile maintenance.

	1951 actual	1952 estimate	1953 estimate
BP-9 Radiation instruments development	$357,764	$401,200	$475,000

The Radiation Instruments Branch has as its primary function the coordination of Commission-wide radiation instrumentation requirements and instrument development activities associated with programs in physical and chemical research, production of radioactive and fissionable materials, reactor development, weapons assembly, health protection, biomedical research, exploration for raw materials and utilization of radioisotopes. The Branch is responsible for the establishment and maintenance of adequate commercial sources of supply for instruments needed by the AEC, its contractors and users of radioisotopes and coordinates the testing of newly developed instruments so that conformance with the Commission's general performance requirements may be achieved.

	1951 actual	1952 estimate	1953 estimate
BP-10 Radiological Laboratory at New York	$226,867	$244,000	$248,000
Man-years (scientific only)	18	19	19

This laboratory provides centralized health service and instrument development work for contractors of the New York operations office (except Brookhaven). Facilities are available for making a large variety of radioactive and chemical analyses, repairs, testing and servicing of radiation detection instruments. The Laboratory has been active in assisting in the measuring of radioactive fall-out following test detonations.

The increase in 1952 and 1953 is to cover the increased cost of materials, and the addition of raw materials and airborne instrument development programs.

	1951 actual	1952 estimate	1953 estimate
BP-11 Schenectady area (KAPL)	$46,199	$100,000	$85,000
Man-years (scientific only)	1	3	3

The following projects are designed to aid in the evaluating of hazards associated with the manufacture and processing of reactor components, and to study the radiation protection problems peculiar to KAPL. New methods of obtaining and studying samples of aerosols are under development and are being applied to studies of shop and laboratory dusts and to evaluation of various filter materials. Counter technique for the determination of tritium as HTO in the atmosphere or in urine samples is in operation and under evaluation. Method of analysis of filter samples for beryllium by direct introduction into the spectrograph without chemical processing is under evaluation. Studies of the permeability and ion exchange capacities for radioactive waste materials of soils in the KAPL operating areas are projected as reduction of effort on the above program permits.

	1951 actual	1952 estimate	1953 estimate
BP-12 University of California at Berkeley	$73,857	$75,000	$84,000
Man-years (scientific only)	4	5	5

Most of the biophysics studies in this laboratory are in the field of effects of high energy radiations, on shielding of high energy accelerators and the nature of radiation at various depths in the shield, including attenuation of star-producing neutrons in concrete. In cooperation with the medical physics group, studies are being made on the effect of high energy neutron fields upon the blood system, and on the quantitative evaluation of the importance of star production and proton recoil in the biological damage done by high energy neutrons. Increased validity has been given to fast neutron survey methods, but instrumentation is particularly needed for quantitative measurements of high energy neutrons. Studies will be continued in instrumentation relating to neutron fields with special emphasis on scintillation counting techniques. Studies will also be continued on the biological effects of the 184-inch cyclotron beam. During the past year these studies have permitted a differential destruction of the pituitary gland in rats by radiation, and will be continued, especially as they pertain to the effects of radiation on specific tissue areas. Health physics problems are anticipated in connection with the operations of the betatron.

	1951 actual	1952 estimate	1953 estimate
BP-13 University of California at Los Angeles	$126,287	$107,300	$110,000
Man-years (scientific only)	11	11	11

Soils are being studied in relation to A-bomb tests. Samples of noncontaminated, contaminated, and trinitite soils are analyzed, as is the physical structure of radioactive material in the air around the trinity site. Soil pulverizers and midget centrifuges are being developed for dust studies. This work also investigates the availability of fission material to plants and animals from A-bomb explosion over a land mass.

Radiation measurement studies are centered around colorimetric dosimetry and scintillation counters.

	1951 actual	1952 estimate	1953 estimate
BP-14 University of Rochester	0	$150,000	$156,000

Toxicity studies will determine what fraction of inspired radioactivity is retained in the lungs and ultimately distributed within the body. An oscillating thermal precipitator and autoradiographic methods of characterizing dusts are being developed.

To determine the body burden of radium, investigations are proceeding on the background radium levels in man, water, and food. Water and food samples are being collected and analyzed for radium content.

Spectrochemical analyses have been successfully developed for uranium, beryllium, zirconium, and thorium, and efforts are being made to improve the sensitivity for detection of fission products.

A porportional counter using methane gas for survey of fast neutron hazards has been made but it needs improvement to reach a stage of calibration for different neutron spectra.

	1951 actual	1952 estimate	1953 estimate
BP-15 Off-site university research program (biophysics)	$771,834	$1,000,000	$1,170,000

In accordance with the directive of the Atomic Energy Act, the Biophysics Branch fosters off-site university research projects in its field ofinterest, thus utilizing scientific services not otherwise available to it. Some increase in the program is required in order that the radiation protection aspects of the biophysics program can cope with the problems of the speeded-up production program. Toxicity effects of elements rarely used heretofore must be studied before large-scale handling of these elements is practical. Use of the continental test site requires emphasis on low-level instrumentation techniques in order to study the effects of radiation fall-out on populated areas.

These activities are in addition to the long-range program which is designed to obtain more adequate data for setting realistic permissible levels of human exposure, both as regards exposure of workers in AEC production facilities and exposure of populations to waste effluents.

Institution	Project	Fiscal year 1951, actual	Fiscal year 1952, estimated	Fiscal year 1953, estimated
Chicago, University of	Use of microbeam of light atomic nuclei for biological investigations.	$84,352	$56,646	$65,424
Do	Amplification of fluoroscopic image to facilitate clinical fluoroscopic procedures and research for development of special photofluorograph.	9,403	0	0
Columbia University	(1) Instrumentation for dosimetry of ionizing radiation. (2) Study of the biological effects of ionizing radiation.	189,946	216,404	187,000

Institution	Project	Fiscal year 1951, actual	Fiscal year 1952, estimated	Fiscal year 1953, estimated
Elgin National Watch Co	Development of high speed electro-mechanical counting register.	$9,033	$10,967	0
Florida, University of	Basic studies in bioelectric potential as a function of irradiation in seeds planoria and mice.	23,791	8,844	0
Harshaw Chemical Co	Radiation detection instrument development.	0	25,000	$25,000
Howard University	Kinetic and mass spectrometric studies of biophysical systems with radioactive and stable isotopes.	17,352	16,500	17,000
Idaho State College	Ecological and radiation background survey.	1,004	0	0
Do	Determination of quantities of certain radioactive materials in ground water and soil in areas in and adjacent to the reactor testing station.	0	15,000	15,000
Illinois, University of	Construction of radio cobalt applicator for biological use.	2,776	0	0
Do	Distribution and effect of radioactive calcium and stromtium in bone development.	11,810	25,000	25,000
Johns Hopkins University	(1) Investigation of absorption and assimilation of radioactive waste in bacterial slimes. (2) Flow and dilution of controlled radioactive wastes.	1,641	0	0
Kansas, University of	Studies of bone metabolism using radium and polonium.	15,198	20,000	20,000
Marquette University	The pathological effects of radioactive isotopes of calcium and strontium on bone and soft tissues.	9,900	14,000	16,260
Massachusetts Institute of Technology.	Biological effects of high energy X-rays and cathode rays.	22,438	1,943	0
Do	The efficiency of present water treatment methods in removing radioactive substances from water.	25,373	30,262	0
Do	Radium and mesothorium poisoning and dosimetry and instrumentation techniques in applied radioactivity.	77,269	101,318	146,500
Michigan, University of	High resolution detection of radioactive isotopes.	10,075	7,830	8,000
Mount Sinai Hospital	Measurement of tissue dosage delivered by gamma and beta active radio isotopes.	2,961	0	0
Do	Investigation of sewage water contamination by radioactive isotopes.	4,978	2,325	0
National Academy of Science	Symposium on basic aspects of radiation effects on living cells.	7,500	5,000	5,000
National Bureau of Standards	Special radiation studies, etc	126,665	126,500	126,500
New York operations	Radiation instrument development	0	3,500	0
New York University	Effects of thorium-x in selected vehicles applied to the skin of man, and the effects of selected pure beta emitters on the skin of man.	19,617	20,000	20,000
Ohio State University	Studies of radioautograph techniques	4,037	0	0
Oregon, University of, Medical School.	Evaluation of body content of radium in individuals with no known exposure.	1,538	2,500	2,500
Pittsburgh, University of	Hazard from inhaled radioactive particulate matter.	33,335	35,000	35,000
Raytheon, RCA	Radiation instrumentation	0	40,000	40,000
Southern Research Institute	Improvement of current models of photoelectric smoke penetrometers.	8,253	16,000	18,000
Utah, University of	Toxicity studies of plutonium and other radioactive substances in animals.	25,252	107,075	155,000
Vanderbilt University	Elementary particle scattering and studies of decay schemes.	0	7,500	7,500
Washington University (Mallinckrodt Institute).	(1) Measurement of clinical X-ray dosages and intensities by means of the use of scintillation media.	11,609	20,304	22,000
	(2) Scanning of in vivo concentrations of radioactivity in an attempt to locate metastic tumors and internal malignancies in the human body.	2,875	11,582	12,000
Washington, University of	Changes in wind speed and direction with height in relation to the vertical temperature distribution	7,960	25,000	15,000
Do	Determination of relationships between the temperature lapse rate, wind speed, and wind shear.	0	18,000	15,000

Institution	Project	Fiscal year 1951, actual	Fiscal year 1952, estimated	Fiscal year 1953, estimated
Wisconsin, University of	Development and application of historadiography in relation to the distribution of mass and localization of elements in normal and pathologic tissues.	$4,073	$10,000	$12,000
	Unallocated for renewals, extensions, or new research projects.	0	0	159,316
	Total, off-site university research program.	771,834	1,000,000	1,170,000

University and special training category

SUMMARY

Activity and location	1951 actual	1952 estimate	1953 estimate
ST-1 Fellowship program in life sciences	$492,308	$510,000	$396,050
ST-2 Special training	284,921	353,000	368,950
Total, university and special training, accrued cost basis	777,229	863,000	765,000

DETAILS

Activity	1951 actual	1952 estimate	1953 estimate
Fellowship program in life sciences	$492,308	$510,000	$396,050
National Research Council	320,353	97,850	15,000
Associated Universities, Inc	24,042	0	0
Oak Ridge Institute of Nuclear Studies	117,202	358,800	327,700
Argonne National Laboratory	11,173	0	0
University of California, Berkeley	19,538	0	0
University of Rochester, industrial medicine	0	53,350	53,350

DETAILS

The fellowship program in the fields of medicine, biology, health physics, and industrial medicine is expected to continue in fiscal year 1952 and fiscal year 1953, with Oak Ridge Institute of Nuclear Studies administering the entire program with the exception of the industrial-medicine program which is under the administration of the University of Rochester. A limited program continued with the National Research Council will culminate in fiscal year 1952. It is planned to continue using the service of NRC during fiscal year 1953 in assisting and advising ORINS on the administration of the renewal program. In recognition of the entrance of the National Science Foundation in the fellowship program, the Commission is limiting fellowship awards in medicine and biology to renewals only during fiscal year 1953 and will discontinue all awards in these fields thereafter. It is planned, however, that the vocational programs, such as health physics and industrial medicine, will continue to be operated under AEC administration because of the fact that the experience and facilities required to conduct these programs are available mainly at AEC installations.

Fellowship costs are based on the following numbers of fellow awards and fellow years:

Type of award	1951 actual			1952 estimate			1953 estimate		
	Fellow awards	Fellow years	Amount	Fellow awards	Fellow years	Amount	Fellow awards	Fellow years	Amount
Postdoctoral:									
Medical	24	28	$112,480	16	22	$88,000	5	5	$22,050
Biological	22	4	15,891	19	18	64,360	5	5	17,750
Predoctoral, biological	157	92	265,061	93	69	174,290	50	61	172,400
Radiological physics	40	29	98,876	60	51	130,000	60	50	130,500
Postdoctoral, industrial medicine	0	0	0	8	8	53,350	8	8	53,350
Total	243	153	492,308	196	168	510,000	128	129	396,050

SUMMARY

Special training:	
1951 actual	$284,921
1952 estimate	353,000
1953 estimate	368,950

There continues to be a need to develop the special function of training in order that the knowledge gained and benefits derived from medical and biological atomic energy research may be profitably disseminated throughout the scientific world. A partial solution has been in the continuing training activities in Commission installations, and these are outlined briefly as follows:

Oak Ridge National Laboratory, $135,000

Education and training.—The purpose of this project is to meet the need for trained health physicists in the AEC installations, industry, universities, hospitals, and other Government agencies, including the military. This need is met by four training programs as follows:

(*a*) Providing health physicists with broad training: A 1-year program conducted jointly with Vanderbilt University.

(*b*) For the National Military Establishment (NME): Two training programs:

(1) One of approximately 6 weeks for the radiological defense graduate students of the Armed Forces special weapons project.

(2) One of 8 weeks for medical officers.

(*c*) Special training for individuals for varying periods of time for familiarity and training in the special sciences and arts associated with atomic energy.

Examples of special training and education activities during the past year were the following:

(1) Training of 24 radiological defense graduate students for AFSWAP.

(2) Completion of a manual, Radiological Protection for Civil Defense.

(3) Completion of training for 11 National Research Council fellows.

Oak Ridge Institute of Nuclear Studies, $163,000

The ORINS program has been designed especially to furnish training needed in the atomic energy field not otherwise available, and serves to furnish scientific knowledge in unclassified areas to qualified individuals not having access to the restricted research being conducted within the Commission's national laboratories. Included under the ORINS program are the following:

(1) Resident graduate program.

(2) Research participation program.

(3) Oak Ridge graduate program.

(4) Radioisotopes courses.

(5) Atomic Energy Museum operation.

(6) Miscellaneous courses.

Oak Ridge area, $10,000

An educational program for the promotion of wider use of isotope material has been under way and because of its effectiveness it is expected to continue. Special programs are planned in health physics, visual aids for technical training, training films, scientific demonstrations, exhibits, and publications.

Brookhaven National Laboratory, $26,000

AEC fellows in radiological physics from the University of Rochester are currently receiving their field training at Brookhaven. It is planned to continue this work, and, in addition, to hold various short course training programs and information sessions for biological and medical personnel with reference to civilian defense and radiological monitoring.

University of Rochester, $34,950

The University of Rochester trains half of the radiological physics fellows in cooperation with the ORINS program; in addition, about 30 graduate students in pharmacology and toxicology, radiation biology, biophysics, and other subjects are carried continually, and about 10 part-time students are enrolled. Included are several predoctorate and postdoctorate AEC fellows, and a number of students assigned from the armed services for studies in special fields. During the past year 30 physicians from the Northeastern States (with observers from Canada and England) were given a course of 1 week's duration in civil defense medicine and 70 nurses from various parts of the United States and from Canada, Puerto Rico, and the Virgin Islands were also given a course.

Additional information of a classified nature is presented in the following pages, 428–450.

DETAILED JUSTIFICATION OF CONSTRUCTION

Biology and medicine subprogram

	1951 actual	1952 estimate	1953 estimate
Cost obligated	$5,184,282	$4,020,900	$515,000
Cost incurred	3,909,208	10,700,000	2,000,000

DETAILED JUSTIFICATION OF COSTS TO BE OBLIGATED IN 1953 FOR CONSTRUCTION

Project No. 6–222–3004—Preliminary studies for facilities, Brookhaven National Laboratory, $15,000

The estimate is to provide funds to initiate a preliminary study of the long-range facility requirements of the Brookhaven Laboratory. It is anticipated that studies will be made of the possibility of permanentizing temporary structures presently in varying stages of disrepair as compared with the long-range need for new facilities. It is further planned that utility studies will be made with a view to present and long-term needs. The completion of this work will provide the basis for planning the future physical growth of the laboratory in an orderly and economical manner.

Project No. 6–222–3001—Miscellaneous site projects, Brookhaven National Laboratory, $225,000

Funds requested to cover the recurring type of repair, alteration, and modification of facilities usual to the operation of a plant of this magnitude. The amount is based on past experience, and review of probable requirements in the ensuing year.

Specific requirements cannot be detailed; the work, however, falls under a number of categories including the following: (*a*) Operational changes in the plant (heating, power, utilities) for the purpose of increasing operating efficiencies, decreasing operating efficiencies, decreasing operating costs, improving safety of operational activities in the plant; (*b*) security and safety improvements including such items as fire stairs, fire doors, sprinklers, fire resistant paint, alarm systems, protection of equipment, fencing; (*c*) changes in heating and air-conditioning equipment due to shifting requirements in various buildings and laboratories, and to increase operating efficiency; (*d*) change in power requirements in laboratories to serve special type of equipment needed to pursue a certain line of research not anticipated at the time of construction; (*e*) radiation protection in various laboratories because of increased level of radiation (hoods, filters, shielding, ventilation, etc.) required not only for the protection of individual laboratories, but also the surrounding territory; (*f*) modifications and alterations to laboratories and their equipment layout (benches, sinks, utilities, etc.) to accommodate changing requirements.

In addition to the various items falling in the various categories given above, there are also many items of a more specific nature which can best be described by examples taken from the list of the work done or begun in fiscal year 1951 under this heading; these include for instance: (1) installation of emergency power motor-generator sets in two boiler houses in order to maintain heat in the buildings in case of general power failure; (2) providing and installing special equipment and hoods in the isotope dilution laboratory in the Biology Department (this involved lead shielding, stainless steel equipment, special fire protection, special filtering of the air, etc.); (3) installation of 200-curie source (remotely controlled) and preparation of gamma-radiation experimental field (fencing, drainage, irrigation, control shack, etc.) for Biology Department; (4) building alterations to adapt former accelerator laboratory building for use as an addition to electronics and instrumentation building; (5) purchase and installation of oil burning equipment in several small heating plants to effect a yearly operating saving greater than the cost of the installed equipment.

Project No. 6–222–3002—Underground steam line, Brookhaven National Laboratory, $50,000

Purpose of the project is to provide high- and low-pressure steam to biology laboratory now under construction. Estimate includes funds sufficient to cover costs of line and steam booster necessary to provide research equipment with high-pressure steam. Project will eventually become a part of a new high-

pressure steam line system now planned, which will result in substantial economies in heating costs when installed.

Project No. 6–241–0042—Temperature and humidity control system, biology laboratory, Oak Ridge National Laboratory, $150,000

Funds are requested to cover the estimated cost of installing a temperature and humidity control system in the biology laboratory at Oak Ridge.

The building was originally designed, constructed, and equipped to be used as a chemical process plant. To provide protection against noxious fumes and to furnish means of heating and cooling the building, a high forced air circulating system was installed.

The present circulating system is very undesirable and inefficient to serve the needs of an experimental laboratory. Dust, fluctuating temperatures, and uncontrolled humidity are the principal undesirable characteristics of this system. It is evident that data received from precise experiments on living organisms vary in degree of accuracy directly proportional to the environment of the organisms. To achieve the optimum accuracy in these experiments the atmospheric conditions must be controlled. The installation of a unit for controlling both temperature and humidity would accomplish this purpose.

Project No. 6–241–2045—General plant projects, Oak Ridge Institute of Nuclear Studies, $25,000

Requested amount is to cover the estimated cost of plant alterations and modifications of a recurring but generally unpredictable nature, and is based on past cost experience for similar projects. These projects will apply particularly to the 30-bed research hospital, special training facilities, and associated laboratories.

Project No. 6–241–3011—General plant projects, University of Tennessee at Oak Ridge, $15,000

The estimate is to cover the cost of plant alterations and modifications of a recurring but generally unpredictable nature, and is based on past cost experience for similar projects. In the operations of the laboratory and 2,500 acres of farm land, past experience has shown the need for funds for such items as fencing, and miscellaneous minor capital changes and improvements.

Project No. 6–221–3007—Miscellaneous improvements, University of Rochester, $35,000

Under this project will be done the work involved in altering and improving the facilities at Rochester which will enable the effective continuation of programs and the changes necessary for the initiation of new research projects.

In the course of operating a research center such as at Rochester, where the Commission owns buildings and equipment, there arises every year, as a normal expectation, certain changes and additions to the plant and equipment which are not within the scope of normal maintenance and repair and which are necessary for the successful pursuit of the purposes of the installation.

It is anticipated that a new sanitary sewer line will have to be constructed from the older buildings to an existing trunk line. At present the sewage from this building flows into the Genesee River under a special dispensation by the board of health, due to insufficient capacity of the area sewage treatment plant. With the increase in that plant's capacity, it is anticipated that the special permission will be withdrawn, and that sewage will have to be directed to the treatment plant

COOPERATION WITH STATE EDUCATIONAL INSTITUTIONS

Senator MAYBANK. So far as the Savannah River plant is concerned, if Senator Thye will bear with me, the Medical College of South Carolina and the general hospital that they have at Charleston appreciates very much the cooperation that it receives from the Atomic Energy group there, and from you, too, Doctor. The president was here the other day and all they wanted to do was to help. They are there and they are paid by the State, and they are only too happy to cooperate in every way possible.

Dr. WARREN. We appreciate their interest, sir, and one of the things that we have tried to do right along is to see that all of the educational institutions are aware of our program, and to enable them

to cooperate in that program whenever possible. We do not want to work only with the large institutions but want all the universities and colleges interested in our program.

This year our program is relatively static as regards costs. There is an actual net reduction in the total program for 1953 because of completion of certain of the major construction projects, although there is a slight increase in the operating part of the budget. Not reflected in our slight increase in operating costs is an increase in the number and complexity of responsibilities that the Commission has had to assume in the field of biology and medicine.

In addition to the new and unexpected hazards to health that have arisen from time to time in the expansion of production of the weapons program, our requirements for general medical services have also increased. With the opening of the continental test site, which is of such tremendous importance to the Commission, our responsibility has increased very largely because it is required that we keep the civilians throughout the country safe.

If I could ask my associate, Dr. Bugher, to bring up one of the types of charts that we use to maintain this safety, and then go briefly over the record, I would like to do that.

RADIATION DETECTION INSTRUMENTS

Very fortunately there is a tremendous spread between the sensitivity of the instruments we use to detect radiation, and the levels that are dangerous to humans, so that we can be quite sure that we are maintaining adequately the safety of the population, both within our plants and outside our plants.

Senator MAYBANK. Have you improved around the plants, the conditions there.

Dr. WARREN. We feel that we have made very material improvements around the plants.

Senator THYE. Assuming that you have these atomic explosions, at, we will say, a dozen points in the United States within the same 24-hour period, or within the same 5-hour period, then how serious would it be?

Dr. WARREN. Well, of course, it would hinge on whether they were controlled explosions, or whether they were ones where the release of energy from the bomb could exert its full destructive effect. There would be enormous destructive effect if they were to be released over urban areas, for example. But so far as this out-fall problem is concerned, if they are air bursts, there would not be a significant problem created at a distance away from the points of explosion.

TREATMENT FOR CASUALTIES SUBJECT TO ATOMIC FIRE

Senator MAYBANK. What advance has been made, Doctor, in treating soldiers or sailors who might be subjected to atomic fire, we will say.

Dr. WARREN. We are putting continuing effort in this with the help of research workers, not only in our own installations but in medical schools and hospitals through the country. We have been able to establish that one of the greatest hazards, the infection due to

the destruction of white blood cells by the atomic radiation, can be controlled.

This is work largely done at the University of Rochester, in our atomic energy project there, and it has been reinforced by work done at the University of Chicago, and work done at Oak Ridge, and elsewhere. We have learned that it is possible by the protection of a significant part of the animal concerned in the formation of the white blood cells, specifically by shielding the spleen of an experimental animal, we can protect the bone marrow of that animal from the degenerative changes that it would otherwise have from radiation.

Senator THYE. How can you protect the spleen?

Dr. WARREN. In that instance, the spleen was chosen because it is an organism in man about as large as your fist, and in an experimental animal about as large as your fingernail, and that in an experimental animal because it has an individual blood supply can be actually swung out of the animal's body, under anesthesia of course, and put in a lead shield.

Senator THYE. That was the question I had in mind.

Dr. WARREN. And what this means is that there is something formed by the spleen or by the bone marrow, which has a protective effect against radiation. We are working hard to try to find that. We have not found it yet. We know that there is some substance that has a specific protective effect there that we are keenly interested in. In relation to other aspects of the bomb explosions, we are naturally concerned with flesh burns, and a considerable degree of progress has been made in understanding these and in working out treatments against them.

Senator MAYBANK. Do the hospitals generally know that?

Dr. WARREN. Yes.

Senator MAYBANK. The civilian defense has a lot of booklets and you have seen them, I understand, and I suppose you have worked with them.

Dr. WARREN. We have helped them with them, and one of the things I am responsible for is the maintenance of a specific branch for liaison with the Federal Civilian Defense Administration to see that information that we develop which is of value is promptly made available to them for their purposes.

Senator MAYBANK. Of course, you have nothing to do with that, but I was wondering about how they were disseminating this information, and of course they will be down here for this appropriation and we will ask them at that time.

Dr. WARREN. I know that they have prepared some very useful and well thought-out pamphlets. I have seen them.

Senator MAYBANK. I have seen them, and I did not think that they would know enough about it, unless you helped them with their studies. They would not have the research or the funds such as you have.

Dr. WARREN. We have been very careful to see that as fast as any facts of practical value are developed, they are made available to FCDA.

One of the problems that concerns us as these new reactors come along for the propulsion of submarines, for example, is the fact that they all have to have crews, and we have the problem of how to protect the crews from the amount of radiation that they may receive.

That is a matter of great importance. We have to be concerned not only with the physical damage that may take place to these individuals unless they are properly protected, but we have also to be concerned with the fact that there is not a mental effect on them that would lead to impairment of judgment, and we are carrying out experiments in psychologic aspects of what happens to exposed animals in this instance. That is done in order that we can be sure that the maximum of efficiency can be maintained for the members of the crews of these very costly and tremendously important aspects of our national security.

Senator MAYBANK. Do you have any questions, Senator Thye?

Senator THYE. I have no questions.

COMMUNITY PROGRAM

Mr. BOYER. The remaining program that we have is the community program. We have a prepared statement which could be inserted in the record on that.

Senator MAYBANK. Without objection the statement on the community program will be included in the record.

(The information referred to is as follows.)

STATEMENT ON COMMUNITY OPERATIONS

The table on page 451, volume 2, indicates that the total net cost of all AEC community operations will drop from $4,037,086 in fiscal year 1951 to an estimated $2,800,000 in fiscal year 1953.

Except for the small Colorado operation, each individual community operation shows a significant reduction in net cost, or increase in operating surplus between fiscal year 1951 and fiscal year 1953.

The table of revenues, just above the table of net costs reveals the principal reasons for reductions in net costs. At Colorado and Los Alamos, dwelling rents have been increased to levels comparable with those prevailing in nearby communities. At Los Alamos, the number of dwellings has also been increased. At Richland and Sandia, revenues increase because more dwellings have been built. At Oak Ridge, replacement of temporary houses with permanent units commanding higher rents has increased revenues. However, because of Federal rent control, no increase in present rents at Richland or Oak Ridge is indicated for fiscal year 1953.

The top table on page 451 gives the gross cost of each AEC community operation. The reasons for increases or decreases in gross costs vary with each community.

In brief summary, they are as follows:

At Richland, the population is expected to increase from 22,000 in fiscal year 1951 to 24,500 in fiscal year 1953. To accommodate this increase, 300 additional houses are now being completed, and an additional 300 are authorized in fiscal year 1952.[1] Gross costs for housing maintenance and school operations will be commensurately increased. At Oak Ridge, average daily attendance in schools is estimated to increase from 6,055 in fiscal year 1951 to 6,717 in fiscal year 1953 which accounts for substantial increases in estimates for total cost of school operations, although per pupil costs are reduced from $287.90 in fiscal year 1951 to $275 in fiscal year 1953. Housing maintenance costs also are estimated to increase due to increases in the amount of housing in active use from a total in fiscal year 1951 of 8,631 units to a total in fiscal year 1952 of 9,050 units. This amount is estimated to decrease in fiscal year 1953 to 8,800 and gross costs are correspondingly reduced in the budget estimates.

At Los Alamos, the population is expected to increase from 12,000 in fiscal year 1951 to 13,360 in fiscal year 1952 and to approximately 14,000 in fiscal year 1953.

In addition, the total amount of housing is estimated to increase from 3,386 in fiscal year 1951 to 3,778 in fiscal year 1952 and to 3,859 in fiscal year 1953. In-

[1] Now anticipated that these will be replaced by 500 title VIII units.

creased costs for additional population and housing are reflected in the gross cost estimates. Gross costs for schools are somewhat reduced in fiscal year 1952 over fiscal year 1951 because the State of New Mexico is assuming a portion of the cost for operating the schools in Los Alamos.

The increase in gross costs at Sandia results from an increase in the number of houses from 387 in fiscal year 1951 to 405 in fiscal year 1952.

Mr. BOYER. I might summarize it briefly by saying that we are asking for $2,800,000 for the operation of the community program in fiscal year 1953. This is less than was requested last year.

Senator MAYBANK. What do you do, just for the record, there?

Mr. BOYER. At our Oak Ridge, Hanford, and Santa Fe operations, we own and operate complete communities needed to house project personnel. This request covers the difference between the cost of operating the communities, and the income that is obtained from the communities. As you know, we have been studying the feasibility of disposing of these communities.

Senator MAYBANK. Of course, you are talking about Oak Ridge and Hanford.

Mr. BOYER. That is correct. Our studies of disposal are progressing now, and we are making a survey of the reaction of the residents in those communities to determine whether or not they would have an interest in buying their homes, and in incorporating as municipal governments.

Senator MAYBANK. What has been the reaction so far?

Mr. BOYER. Well, the Census Bureau is making this survey for us, and we have not received the residents' reaction yet. That will be summarized and tabulated, and from that we will determine the course the Commission will follow.

Senator MAYBANK. When do you expect to have it?

Mr. BOYER. That survey is supposed to be finished by, I believe, the 1st of May; we hope that the census survey will be finished about that time.

Mr. TOWNE. The timing, as to what happens after that, is difficult to pin down. It is going to be difficult to name any specific date as to how long it will take the Commission to appraise the results of the survey and take into account the other considerations that it is faced with, and to develop legislation for submission to Congress, which is the normal sequence of events.

Senator MAYBANK. Hanford and Oak Ridge would be the only two places.

Mr. TOWNE. Those are the only two communities which the consultants recommended could reasonably be considered for disposal.

Senator MAYBANK. What other places would you have that you would not want to dispose of.

Mr. TOWNE. Los Alamos is the principal one, and of course we have some houses at Sandia, which is on a military reservation and it would not be feasible to dispose of those.

Senator MAYBANK. What about Nevada?

Mr. TOWNE. We do not have any family housing there, that I know of.

Senator MAYBANK. How about the new plants that you are building at Paducah, do you believe that you did the right thing when you determined not to go into any communities?

Mr. TOWNE. Yes, sir. It appears now that our prospects for getting housing for our permanent operating personnel at Paducah

and Savannah River are very favorable, due to the way in which the Defense Housing and Community Facility Act is working to assist private enterprise. There are, of course, as you know, Senator, some problems that remain to be explored, and we are still new at it, and it is not too certain as to how well off we are going to be with regard to access to the secondary market for mortgages.

Senator MAYBANK. Of course, that may be temporary, and it may not be temporary, I do not know, we had the mortgage bankers here for 3 days before the committee last week, and some people seemed to think that the interest rates were the main cause, and others seemed to think that there was more than interest rates involved.

Mr. TOWNE. We are concerned, also, as to whether or not the features in the Defense Housing Act which related to Federal aid to the local government for expansion of their community facilities and services will be fully effective in time to assure the housing that we need.

Senator MAYBANK. Of course, in my judgement, and Congress, of course, did not agree with what I thought, I think we cut it a little too much, because not only with you but with the various military installations that need it, there is a tremendous demand there.

Mr. TOWNE. We have had extremely good cooperation from Mr. Foley, Administrator of the Housing and Home Finance Agency, in making the limited funds they do have available serve our purposes.

Senator MAYBANK. I understand that they have come back this year, as they did in the supplemental bill last year, to ask for the difference between the $65 million that the Senate authorized in the housing and community facilities programs, and they want $25 million more for this year. That would be $90 million less what they got. I do not remember what they got, I think it was $15 million. They are asking for $69 million.

Mr. TOWNE. We are watching the requests this year with great interest, although, of course, we are not really capable of making the necessary estimates.

Senator MAYBANK. I understand, all you can do is cooperate with the program.

TEMPORARY HOUSING

Mr. TOWNE. That is right, but we keep very close contact with them as you know. With regard to our temporary housing, at Paducah we are at peak employment now and we have opened up the 500 dormatory units that we built with appropriated funds. They are virtually filled at this time. There appears to be no problem with regard to housing our temporary construction personnel at Paducah, in view of the fact that we are past the worst of our hump or at the peak of employment. At Savannah as you know, we have two contracts of a unique character, with private investors, one to provide dormitory facilities for single workers, and one to provide family accommodations in the way of trailer coaches for our construction families.

One of the dormitory projects, the one near Barnwell, has been completed and it is filling up now at a fair rate. The last figures that I had which were as of several days ago, indicated, I believe that we had two-hundred-and-ninety-odd persons living in this 1,500 unit dormitory facility. That opened on the 14th of January.

Senator MAYBANK. Do you intend to build any more around there?

Mr. TOWNE. No; we feel at this time, Senator, that the 7,500 dormitory units we have contracted for—we are contracting for occupancy control only—will meet our foreseeable requirements, and that the 4,000 trailer-coach units will meet our requirements for families.

Senator MAYBANK. Most of the people come from 25 to 50 miles to work anyhow.

Mr. TOWNE. We anticipate that some of those people of course will move in closer as these accommodations become available. That is not all of them, however. The first increment of family trailers, 350 units, we now figure will open for beneficial occupancy this coming Thursday, and we had planned to open them Monday, but the week-end was rainy and they were unable to finish up some of the street work. By the 1st of March we anticipate we will have 1,000 trailers ready for occupancy, and we have about 250 people on the waiting list at the moment.

RECREATIONAL FACILITIES

Senator MAYBANK. How about the recreational facilities?

Mr. TOWNE. We have received a letter accompanied by a very interesting report from Mr. Foley. As you may know, he retained as a consultant, Mr. Philip Klutznick, who went down and made a personal investigation of our temporary housing program. As a result of that, we received a letter from Mr. Foley, in his capacity as Mr. Wilson's deputy, suggesting that among other things the recreational facilities available to the inhabitants of these temporary projects be expanded, or improved. He suggested a division of responsibility between the Housing and Home Finance Agency, the Federal Security Agency, and the Atomic Energy Commission. That is the Atomic Energy Commission would take care of the needs of the residents on the project sites, in the construction camp areas, and that the other two agencies would take care of the problems in the surrounding communities. We are working out now a plan for the mutual sharing of this responsibility.

It will require possibly some adjustment in our contract arrangements.

EDUCATIONAL FACILITIES

Senator THYE. And what of your educational facilities that will accommodate the youth there, the school children.

Mr. TOWNE. Senator, the educational problem, of course, is a very difficult one. Fortunately for our program, Public Law 815 and Public Law 874 which provide for Federal aid to school districts impacted by Federal programs were already in effect at the time that our site was selected. So by vigorous cooperation from the United States Office of Education we were able to get a head start in making the plans for the provision of school facilities to take care of the influx of added pupils. Now, the actual effect of the program, getting the additional school facilities built, has moved a little bit slowly, and a little slower than we would like, due to a number of complications involved in administering any new law.

However, it now appears that the school capacities will be available in time to take care of the worst of our impact. Our principal problem

on the schools was not due to the in-migration of new pupils, but to the fact that our program required that the residents of Ellenton, which is inside of the project site, be evacuated from the project area by March 1, I believe. We were able, however, with the cooperation of the Office of Education and the Housing and Home Finance Agency to speed up the completion of a new temporary school at Jackson, and it is now going to be ready in time to take care of those children. I think that our school problem at the moment is fairly well in hand. This is a novel and unprecedented way in which to get our housing and our community problems solved but it appears that by full cooperation on the part of all of the agencies involved, we are going to be able to make it work.

Senator MAYBANK. That is better than having a city like Oak Ridge.

Mr. TOWNE. We think a great deal of effort would be worth while in order to avoid having another community under our direct responsibility. It takes an excessive amount of time and effort to work out these problems now, but I believe it will pay off later, when others will have the responsibility of carrying it on.

Senator MAYBANK. Are there any further questions?

Sentor THYE. I have no questions.

Mr. BOYER. I believe that concludes our presentation. We have certain items concerning inventories and the like and I think we can ask Mr. McCarthy to work with Mr. Cooper to make proper insertion of materials in the record.

Senator MAYBANK. That may be done.

Mr. BOYER. Maybe it would be well for them to review other insertions in the record to see that that is properly done.

Senator MAYBANK. We would like to have the record as complete as we can.

(The material referred to is as follows:)

SUMMARY OF CHANGES IN OPERATING STORES INVENTORIES

	Fiscal year 1950	Fiscal year 1951	Fiscal year 1952	Fiscal year 1953
Stores inventory as of June 30:				
Current use and stand-by	$62,802,876	$69,523,574	$76,916,000	$79,455,193
Excess	21,987,533	7,390,339	4,201,000	5,923,363
Total	84,790,409	76,913,913	81,117,000	85,378,556
Increase or decrease		−7,876,496	+4,203,087	4,261,556
Adjustment for nonbudgetary increases (−) or decreases (+) in inventories		6,425,243	1,747,285	−1,059,556
Net increase or decrease		−1,451,253	5,950,372	3,202,000

GENERAL STATEMENT

Current use and stand-by stores inventories include all operating inventories of supplies, materials, and spare parts which represent a deferred charge to cost of production of source and fissionable materials and weapons or to the cost of operation of laboratories, towns, and administrative facilities. Source and fissionable materials and weapons components and special materials are not included in stores inventories as the cost of procurement or processing such items is included under separate schedules in this budget. Construction materials and supplies are charged to construction work in progress and are therefore not included as stores inventories.

Current use stores inventory represents those usable stocks of supplies and materials which are required to support current operations. Stand-by stores inventory consists of special spare parts designed and fabricated for equipment used exclusively at AEC plants. These stocks are held in reserve to insure uninterrupted operations of vital processes. Excess stocks are those stocks of materials and supplies which have been declared as excess or are estimated to be in excess of the needs of the AEC. The decrease in intenvories due to disposal of excess stocks is excluded for budget purposes when it does not affect fund requirements.

A net increase in the stores inventory represents additional obligational authority required. A net reduction in the stores inventory reflects that portion of current costs met through the utilization of stocks on hand and therefore represents a decrease in the obligational authority required.

During the past three fiscal years the AEC has made a continuous effort to keep inventory at a minimum level consistent with operating requirements. Through careful control and effective supply management the level of inventory has dropped from $90.5 million at the end of fiscal year 1949 to $76.9 million at the end of fiscal year 1951. The latter amount includes $2 million of special items which were transferred from special materials inventory to current use and stand-by stores inventory. Although the operating program has greatly expanded during this period, the reduction in stores inventory was accomplished without curtailing the operating program. The reduction was made possible by achieving a better utilization of stores combined with a vigorous program of disposal of all excess stock. At the present time the AEC current use stores is valued at $43 million which represents less than 1 year's investment in relation to AEC issues.

The fiscal year 1953 estimate of $3,202,000 is required to provide the minimum level of inventories necessary to support the operating requirements of the AEC. This amount will enable an expansion of the stores inventory to a level of $85.4 million at the end of fiscal year 1953. This represents an increase of 11 percent over the fiscal year 1951 level, as contrasted with an estimated 92 percent increase in operating costs during the same period. It is estimated that the current use inventory in fiscal year 1953 which will be provided by this funding will represent less than 8 months' investment in relation to the AEC's issues. The increase of $3,202,000 covered by this estimate is needed to effect inventory support at new plants which will go into operation in late fiscal year 1952 and fiscal year 1953, to cover expanded programs at existing plants and to provide an additional stockpile of special items. These increases total $6,914,125. This amount is in part offset by improved utilization of inventories at existing plants and by decreasing operations at other plants which will reflect a savings of $3,712,125, leaving a resulting funding requirement of $3,202,000. These requirements are distributed as follows:

New plants	$5, 423, 125
Expanded programs at existing plants	1, 016, 000
Addition of special items	475, 000
Subtotal	6, 914, 125
Less improved inventory utilization and decreasing operations	3, 712, 125
Total funds required	3, 202, 000

CHANGES IN SPECIAL REACTOR MATERIALS INVENTORY

	Fiscal year 1950	Fiscal year 1951	Fiscal year 1952	Fiscal year 1953
Inventory at close of year	$6, 702, 293	$13, 303, 606	$17, 567, 004	$18, 292, 504
Gross change during the year		+6, 601, 313	+4, 263, 398	+725, 500
Adjustment for nonbudgetary changes		−204, 656	−5, 049, 794	+4, 835, 500
Net change during the year		6, 396, 657	−786, 396	5, 561, 000

Special reactor materials inventory includes stocks of those special materials which are required for the construction and operation of production, research and developmental reactors. The increase in fiscal year 1953 will provide mainly for zirconium metal to be used in several of the newer type reactors. Special reactor materials are an integral part of the technical advance to improve reactor performance. Additional details are set forth on pages 652 through 661 which are classified as "secret."

SUMMARY OF CHANGES IN SPECIAL MATERIALS INVENTORY

Net changes in special materials:	
Fiscal year 1951	$243,076
Fiscal year 1952	2,019,895
Fiscal year 1953	2,037,000

GENERAL STATEMENT

Special materials inventory includes stocks of precious and semiprecious metals having a high unit cost which require special accounting treatment. These are distinct from the special reactor materials. These special materials are used in the production and research programs. The increases are due mainly to increased production and research.

Details of the changes are shown on pages 667 through 671–676, inclusive, which are classified as "Secret."

BUDGET ESTIMATES—FISCAL YEAR 1953

Analysis of changes in operating working capital

	Actual, fiscal year 1950	Actual, fiscal year 1951	Estimate, fiscal year 1952	Estimate, fiscal year 1953
Balances as of June 30:				
Collateral funds	$44,889,286	$45,527,144	$44,683,000	$44,683,000
Other working capital	31,609,574	41,657,676	23,625,597	24,325,597
Total working capital balances	76,498,860	87,184,820	68,308,597	69,008,597
Increase or decrease (−) during the year		10,685,960	−18,876,223	700,000

Collateral funds.—This item consists of insurance collateral funds, employee benefit and annuity funds and excess premium payments. The funds are designed to provide for various extraordinary contingencies in the activities of cost-type contractors. For the most part they are held by trustees and invested in United States Government securities. The fund balances are being held to approximately the current level despite the increases in the operating program for fiscal year 1952 and 1953.

Other working capital.—This item represents the net difference between current assets and liabilities other than appropriation cash, inventories and unliquidated obligations for operations on the books of the Commission and its integrated contractors which must be considered in reconciling operating costs computed on an accrual basis and obligations for operations. Notwithstanding the continued expansion in the operating program as indicated by the trend in operating costs of $400 million in 1951, $615 million in 1952, and $768 million in 1953, the estimates reflect a general decrease in net cash working capital.

A summary table of working capital changes by area follows:

Summary of changes in operating working capital—increase or decrease (−) in working capital

Area	Actual fiscal year 1951	Estimate fiscal year 1952	Estimate fiscal year 1953
Raw materials	$1,816,887	−$273,073	−$3,941,015
New York	917,489	659,551	1,300,000
Brookhaven	−1,069,988	137,402	25,000
Hanford	−7,793,834	−7,977,930	0
Oak Ridge	4,046,072	−3,927,564	959,400
Dayton	23,464	69,586	0
Savannah River	89,072	1,630,928	1,350,000
San Francisco	0	200,000	200,000
Santa Fe	15,751,559	−8,660,866	0
Idaho	−734,453	299,322	0
Chicago	225,906	225,549	120,000
Lockland	0	0	1,000,000
Ames	540,859	0	0
Argonne	270,064	−52,128	65,000
Berkeley	−40,909	73,523	75,000
Pittsburgh	−275,088	450,000	0
Schenectady	159,609	−57,450	88,649
Washington military application	−1,250,518	−364,242	−65,996
Washington reactor development	−274,993	0	0
Washington research	−1,002,180	−592,347	−400,000
Washington biology and medicine	−611,451	−716,484	−50,000
Washington administration	−101,607	0	0
Round-off of estimate	0	0	−26,038
Total	10,685,960	−18,876,223	700,000

The details of changes in operating working capital by Commission Office and contractor are set forth in the following classified pages 679 through 705.

ANALYSIS OF CHANGES IN UNLIQUIDATED OBLIGATIONS

	Actual		Estimate	
	Fiscal year 1950	Fiscal year 1951	Fiscal year 1952	Fiscal year 1953
Unliquidated obligations as of June 30:				
1. For operating contractors' costs to be incurred in ensuing year	$269,142,629	$328,052,401	$380,738,735	$404,243,669
2. For operating contractors' commitments outstanding at close of ensuing year	40,774,837	29,382,027	87,021,145	87,277,585
3. For carry-over under miscellaneous procurement contracts, purchase orders, etc.	39,143,179	42,011,641	49,859,149	48,297,775
Total	349,060,645	399,446,069	517,619,029	539,819,029
Net increase or decrease (−) during the year		50,385,424	118,172,960	22,200,000

GENERAL STATEMENT

Unliquidated obligations for operations represent the amounts required at the end of the fiscal year under contracts for the operation of Commission production facilities and laboratories, etc.; for deliveries of goods and services under direct procurement.

These estimates are predicated on the assumption that the Commission will continue to obligate annually in advance under contracts for the operation of Commission-owned production facilities and laboratories amounts sufficient to cover the anticipated commitments to be made by the contractors through the end of the ensuing year. Obligations under contracts for the operation of community facilities are on a current basis, that is, the obligation is incurred at the beginning of the fiscal year for commitments to be made by the contractor during the year.

JUSTIFICATIONS

1. For operating contractors' costs to be incurred in ensuing year, increase, $23,504,934

The estimated unliquidated obligations of $404,243,669 outstanding as of June 30, 1953, reflects the projected level of costs to be incurred during the fiscal year 1954 by contractors operating the Commission-owned production facilities and laboratories. The continued increase in this item indicated in the above table reflects primarily the expanded production of source and fissionable materials and weapons.

2. For operating contractors' commitments outstanding at the close of the ensuing year, increase, $256,440

The estimated unliquidated obligations outstanding as of June 30, 1953, in the amount of $87,277,585 are required in addition to working capital to cover the outstanding commitments of contractors operating Commission-owned production facilities and laboratories at the end of the ensuing year. Contracts for such purposes are amended annually in advance to cover the estimated commitments (liabilities) to be incurred by the contractor during the ensuing year. The commitments incurred, on a continuing basis, will equal operating costs incurred under the contract plus commitments outstanding at the end of the period.

3. For carry-over under miscellaneous procurement contracts, purchase orders, etc., decrease, $1,561,374

The estimated unliquidated obligations of $48,350,481 outstanding as of June 30, 1953, reflect uncosted balances of contracts, purchase orders and other obligations incurred directly by the Commission. They include such items as raw ores, materials, supplies, utilities, equipment, offsite research contracts, etc.

The requirements for these purposes by area are as follows:

	Fiscal year 1950	Fiscal year 1951	Fiscal year 1952	Fiscal year 1953
Raw materials	$8,529,530	$10,436,157	$9,372,192	$10,852,942
New York	6,404,822	1,624,067	1,992,535	1,792,144
Brookhaven	2,961	5,301	3,000	3,000
Hanford	3,343,131	4,607,461	4,692,376	4,342,376
Oak Ridge	1,062,000	948,898	630,000	605,000
Dayton	21,162	48,031	2,020,000	20,000
Savannah River		43,000	57,000	66,000
Santa Fe	8,631,212	9,452,528	5,971,016	5,971,016
Chicago	415,659	749,386	56,867	56,867
Ames	34,657	59,072		
Argonne	79,315	165,471	56,867	50,000
Berkeley	8,376	6,830	5,164	5,164
Pittsburgh	4,700	1,142,661	2,186,400	2,177,100
Schenectady	152,384	18,426	25,900	26,300
Washington:				
Production Division		12,260	12,260	12,260
Military Application Division		78,732		
Reactor Development Division		1,290,530	9,782,000	6,890,000
Physical Research Division	4,254,789	5,638,768	6,893,484	8,746,078
Biology and Medicine Division	5,457,141	5,061,472	5,477,498	5,984,644
Headquarters	741,340	622,590	624,590	749,590
Total	39,143,179	42,011,641	49,859,149	48,350,481

Details of the changes are shown on pp. 708 through 735–740 which are classified as "Secret."

SUMMARY OF OBLIGATIONS AND EXPENDITURES

	Operations	Plant and equipment	Total
Unliquidated obligations at June 30, 1951	399.4	1,391.8	1,791.2
Add 1952 obligations	721.2	585.6	1,306.8
Total	1,120.6	1,977.4	3,098.0
Less expenditures, 1952	603.0	1,097.0	1,700.0
Unliquidated obligations at June 30, 1952	517.6	880.4	1,398.0
Unliquidated obligations at June 30, 1952	517.6	880.4	1,398.0
Add 1953 obligations	801.5	453.5	1,255.0
Total	1,319.1	1,333.9	2,653.0
Less expenditures, 1953	779.3	970.7	1,750.0
Unliquidated obligations at June 30, 1953	539.8	363.2	903.0

Mr. BOYER. We thank you very much.

Senator MAYBANK. We will stand adjourned until we can arrange for further meetings.

(Whereupon, at 11:50 a. m., Tuesday, February 19, 1952, the hearing adjourned subject to the call of the chairman.)